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Finnish National Road Administration
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ROADS AND WATERWAYS ADMINISTRATIONS OF FINLAND

Overseas Projects Office

DEVELOPING THE FOLLOW-UP SYSTEM OF THE CONTAINER TERMINAL WORKSHOP

Finnish International Development Agency

Publications of Export Services

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FOREWORD

This research was made by the RWA (Roads and Waterways Administrations), which carries out the overseas projects of the Finnish National Road Administration (FinnRA) and the Finnish Board of Navigation (FBN). The research was financed by FINNIDA. The reason for the research was the need to clarify and improve the current information system of the Container Terminal Workshop in the Dar Es Salaam Port, Tanzania. This study is also intended to benefit other similar projects in developing countries.

The work was originally written in Finnish and accepted by the Helsinki University of Technology as a Masters Thesis in the end of may 1991. The work was translated into english during the summer of 1991. The author has been employed by the RWA since 1987 and has now completed his studies in the Mechanical Engineering department majoring in Production Technology.
The research subject was agreed upon in september 1990 during the first fact finding mission and it was accepted by the University in november. The final study was made in november 1990 in Dar Es Salaam. The research was prepared during the spring of 1991.

The research concentrated on defining the essential information needed by the workshop management. As part of the work a computer program was designed for gathering information and reporting. The main conclusions that can be drawn from the research are :

The current information system is in poor shape because it has been neglected in the overall development of the port.

The workshop will in future be very hard to manage without a systematic gathering and analysis of maintenance information. The insufficient equipment follow-up will cause a serious problem in the future.

The information system of both the port and the workshop can be developed step by step. First the smaller department and unit systems are developed. Then the need for data exchange between the systems is defined and after which the separate information islands are combined into an overall system.

Developing the follow up system in a container terminal workshop

0 GOALS

The goal of this work is to improve the cost- and equipment service follow up. The idea is to develop the information system by defining the basic information requirements and in accordance to that create a simple system, which can easily be automated. The work will also be a study of the current situation in the container work shop, which can be used as a guide line when planning new development projects.

This study was made specifically for the Finnish National Road Administration (FinnRA)/Overseas Projects Office, which administrates several projects for the Finnish International Development Agency's (FINNIDA). The research for this study was done at the port of Dar Es Salaam in Tanzania. FinnRA has been administrating a development project in the port since 1986. The project is currently in the second phase which will continue until the end of 1993. Additional background information for this research has been gathered from some Finnish ports.

1 THE INFRASTRUCTURE OF THE PORT

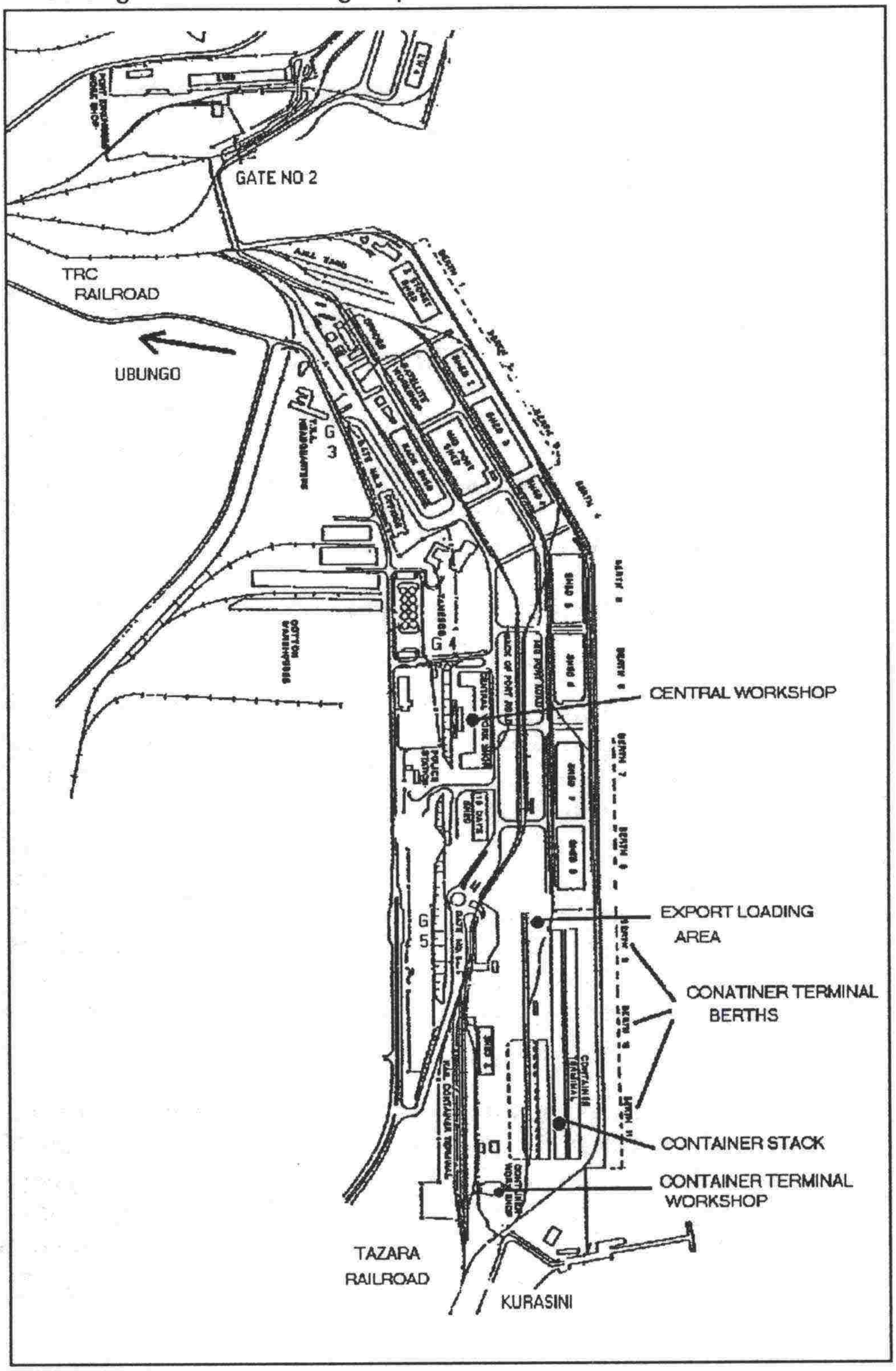
GENERAL:

The ports join together water- and land transportation systems. They are huge investments and their operations are usually totally or partially run by the government. This is true especially in developing countries. Ports are important as nodes and starting points for the transportation routes. They play also an important role as generators for work and foreign currency. The importance of ports is higher in the poor countries, where ports are the main sources of foreign currency while exporting goods abroad. At the same time they receive imports of machinery and raw materials which are needed in production.

Ports are categorized according to their cargo handling equipment. A port can specialize in bulk-, oil- or container cargo. The handling strategy depends on the region where the port is situated. In regions where competition exists, it's better for the ports to specialize, whereas in regions where little or no competition exists and where there are only a few alternative transporting routes, a port should be able to offer multiple services.

DAR ES SALAAM:

The port of Dar Es Salaam (Picture 1) is the most important port in Tanzania and it is also part of SADCC-group, which is trying to reduce the dependence of the sovereign southern African countries on the Republic of South Africa. Therefor actions have been taken to develop alternative transportation routes for the countries that belong to the SADCC-group.



Picture 1 Dar Es Salaam port

A great part of the Zambian cargo traffic and also part of the Malawi and Zaire cargo traffic goes through Dar Es Salaam. Other ports on the east African coast are Mombasa (Kenya), in the north and Nacala and Beira (Mozambique), in the south. There are however some problems with these ports. In Mombasa, union problems cause sporadic strikes whereas the traffic trough Mozambique suffers because of the guerilla activity which prohibits cargo transports across the country.

The condition of the railways and roads in the southern African countries is however poor. Therefor even close situated ports aren't real alternatives. Inland countries have usually only one main transportation route, which is maintained in order to keep it at least in satisfactory condition. This is the reason why the main ports on the east African coast don't compete over the same customers. The best, however usually the most expensive, transportation routes go through the Republic of South Africa. According to the 1988 statistics the traffic through the ports were as follows /7/. The figures for Mombasa were not available.

	Traffic	1988		
	DSM	Nacala	Beira	Maputo
Dry cargo				
x1000 tons	2090	472	1400	2159
TEU	56000	3600	15279	7681
containers				
x1000 tons	796	51	217	109
% of traffic	38	11	15,5	5

Of these ports the cargo tons through Dar Es Salaam (DSM) in were 1988 the greatest. The difference between the ports is even greater when comparing the container figures. Maputo (Mozambique) has proportionally the lowest container traffic. A TEU is a twenty foot container equivalent, which enables the use of one unit for different sized containers. A 40 foot container is therefor 2 TEUs. The container tons in the table are an approximation of the medium container weight (70 % of the total weight of a fully loaded container) multiplied with traffic. The figure showing the container tons is a very rough one, still, it clearly shows that the container traffic in the other ports compared to Dar Es Salaam were very small.

The activities in the Tanzanian ports are administrated by THA (Tanzanian Harbours Authority), which is responsible for the ports of Dar Es Salaam, Mtwara, Tanga and some other smaller ports. The THA was founded in 1977, before which the ports were administrated by the East African Harbour Company. The responsibilities of the THA consists of the construction, development and administration of the ports./7/

The port of Dar Es Salaam is divided into a oil jetty, general cargo harbour (berths 1-8) and a container terminal (berths 9-11). The biggest maintenance units are the central workshop and the container terminal workshop. The central workshop is lacking both tools and skilled maintenance personnel. The development project in the central workshop is only starting. This work will concentrate on the container terminal workshop, where the maintenance of equipment is already going on. The workshop is in a phase, where a natural step of is to develop a follow up system of the maintenance work. The container terminal is clearly an independent part of the port both in regional and in financial sense, although a smaller part of the container traffic goes through the general cargo berths.

1.1 The Activities in a Container Terminal

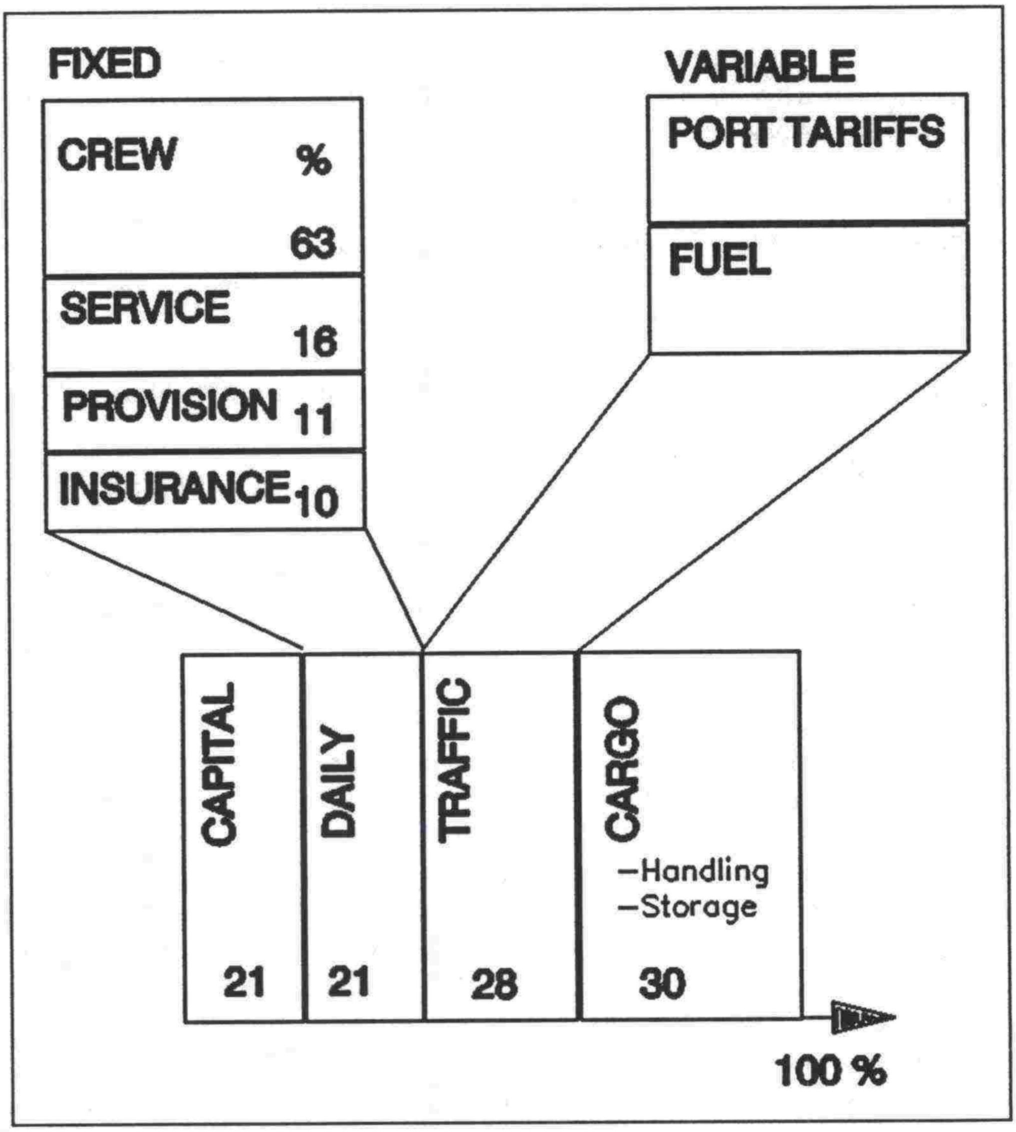
GENERAL:

The objective of the container terminal is to offer quality port services in a competitive price. The task should be accomplished and the port should make large enough profit to cover the investment in the modernization of old machinery and to generate the planned surplus.

The container terminal has to offer effective container handling services, both for inbound and outbound traffic, to be able to interest its customers. The aim is to speed up the ship return time and to minimize the cost of waiting period. The overall cost of a ship used by the shipping companies is divided fairly evenly between capital and cargo costs and traffic and daily costs. (Picture 2).

The division into daily and traffic costs depends upon the type and size of the ship. The daily costs are indifferent to whether the ship is at berth or sailing. The crew cost is usually quite significant, especially for the ships of countries with a lot of social salary add ones. The ships sailing under convenience flags have usually approximately 10 % lower crew costs than for instance the ships belonging to the Finnish merchant fleet. /5/

Keeping the ship at berth is quite expensive for the shippers. The plain running costs for medium sized container vessel, excluding the harbour fees, are estimated to be 15 000 USD/day /7/. The handling efficiency is one of the most important sales arguments between competing ports on the same transportation route.



Picture 2 Cost Structure of Ships

Factors affecting the total efficiency of a container terminal :

- The efficiency of the handling machinery
- The efficiency of the operations and their planning
- The speed of the port formalities (customs etc.)
- The timing and efficiency of the connecting cargo transportation

Economic activity needs a proper cost follow up system for support. The system should make it possible to compare the in- and outcome of the port. A cost follow up is not only for the estimating of the internal result but offers a way to justify the need for investments. The ports in developing countries, especially in the poorer ones, have to compete for foreign currency with other sectors of the economy. /5/.

Even though the ports generate a significant part of the total foreign currency in the developing countries, they are allowed to use only part of it for investments. While the purchases of equipment and spares have to be made in foreign exchange, it especially puts the maintenance sector in a spot. The importance of maintenance isn't always clear in the ports of developing countries.

DAR ES SALAAM:

The cost follow up and the budgeting in the port of Dar Es Salaam are in poor shape. Budgeting is done with the break down method and it's based on the previous budgets which are corrected with indexes. The port lacks a follow up system, which would cover the whole port, cost follow up is done more or less randomly than systematically. When the port tariffs are defined on this basis the reality of the calculation factors disappears and the picture of the port economy is distorted.

There are quite a few development and aid programs going on in the port of Dar Es Salaam, the programs are financed especially by the Nordic countries. The World Bank also finances and gives support for studies. When the projects are proceeding there will be purchases of essential supplies and spares. These purchases are not usually accounted for when the result of the port is calculated. This causes additional distortion when the result is evaluated.

1.1.1 Traffic Analysis

GENERAL:

The Operational Department (later referred to as the Operations) is responsible for the logistics of the port, that is, how the machinery is used to handle the cargo and where it should be stored. The Operation plans and organizes the daily loading and unloading program according to the incoming ships.

Before the arrival of the ship the Operation has the ship manifests, which include the information about the amount and type of cargo the ship is going to discharge or take in different ports. The Harbour masters office shows an incoming ship to a berth and the Operations will allocate usually two gangs of 15 workers for every shift. The Operation will also allocate a sufficient amount of equipment, usually two or four terminal tractors with trailer for each ship.

The container traffic can be divided into import, export and transit. The transit containers are discharged in the port of one cargo but the final destination is in some other country. The containers are classified depending on the cargo as FCL (Full Container Load) ,LCL (Less Container Load) and empties. Depending on the way containers are handled they are separated into :

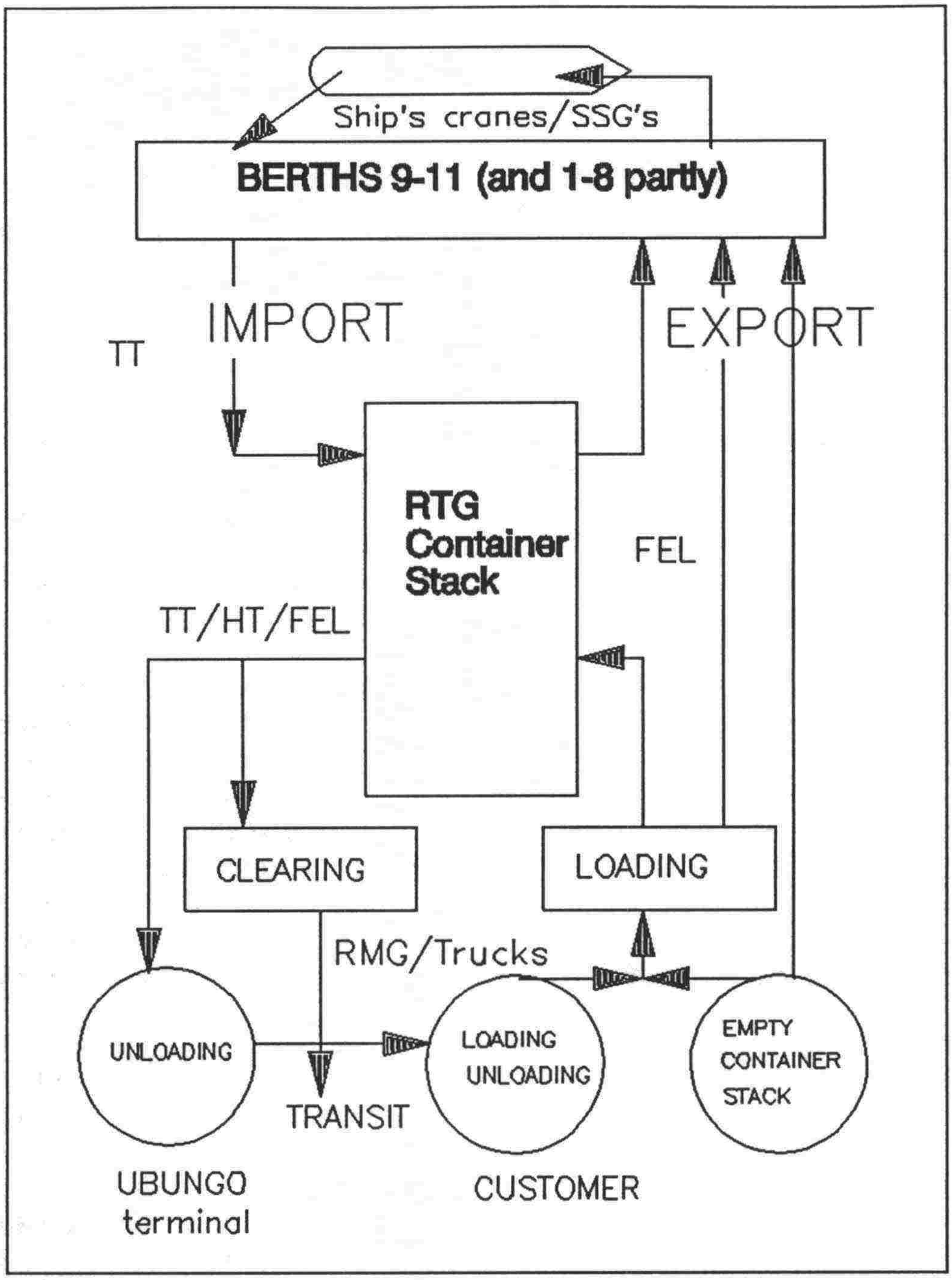
- **H/H House to House** containers, which usually are loaded by the sender and which will be transported to the consignee for unloading.

- **P/P Port to Port** containers, which will be unloaded in the port when they become empty containers when the cargo is forwarded to the consignees.

- **Empty** containers, which are shipped out, stored or loaded in which case they become P/P containers.

The containers belonging to different groups may be handled with different equipment and they may move through different routes in the port (Picture 3). The choice of route or equipment is a question of economy, for instance the handling of empty containers can be done by an older machine or a machine with less capacity.

An important factor in the port transport system is the so called Dwell Time, which means the time a container lays in the port before it's shipped out. Long dwell times will congest the container stacks slow down the handling in the port.



Picture 3 Traffic Analysis

DAR ES SALAAM:

Work involved in the export of containers is easier from the operational point of view and it's smaller compared to the import. The dwell time of the export containers is not a problem because it's duration is only 3-6 days /2/. The export containers are loaded under the customs supervision either in the stevedoring company's store or in the loading area in the port. The plan is to do most of the loading at the Kurasini satellite terminal. Only 20 % of the export containers are moved through the container stack. The export containers are often transported to the berth to wait for the arrival of the ship.

Import is a complicated process. The easiest group to handle is that of the empty containers, which are currently taken into the port on special grounds only. The idea is to keep the amount of the empties at the current level. The empty containers don't go through the container stack. There is an area in the southern part of the port for a smaller amount of empties.

The P/P containers move through the port quickly. After being discharged from the ship a P/P container is moved to block C in the container stack. From the stack the container is quickly moved to either a forwarding agent's warehouse for unloading or to the Ubungo satellite terminal, from where the cargo is transported to the consignees in Tanzania or in the neighboring countries. The volume of P/P containers is however only 20 % /2/.

The H/H containers are a problem. The dwell time will easily go up to 30 days. The containers move through the stack (block A and B) and the forwarding agents move their containers quickly to their warehouses in order to avoid the storing costs of the port. The dwell time problem is caused by private consignees, who can't afford to take out the container or whom the information of the arrival of the cargo has reached late. Another cause for the problems are the state offices, which are usually slow in taking out their goods. Although the Tanzanian law gives the right to auction off unclaimed goods, the law doesn't apply to the cargo destined to the neighboring countries. These transit containers will stay in the port if the consignee is unable to pay the handling charges of the port.

The traffic in the container terminal is expected to grow during 1990-1993. The general trend is:

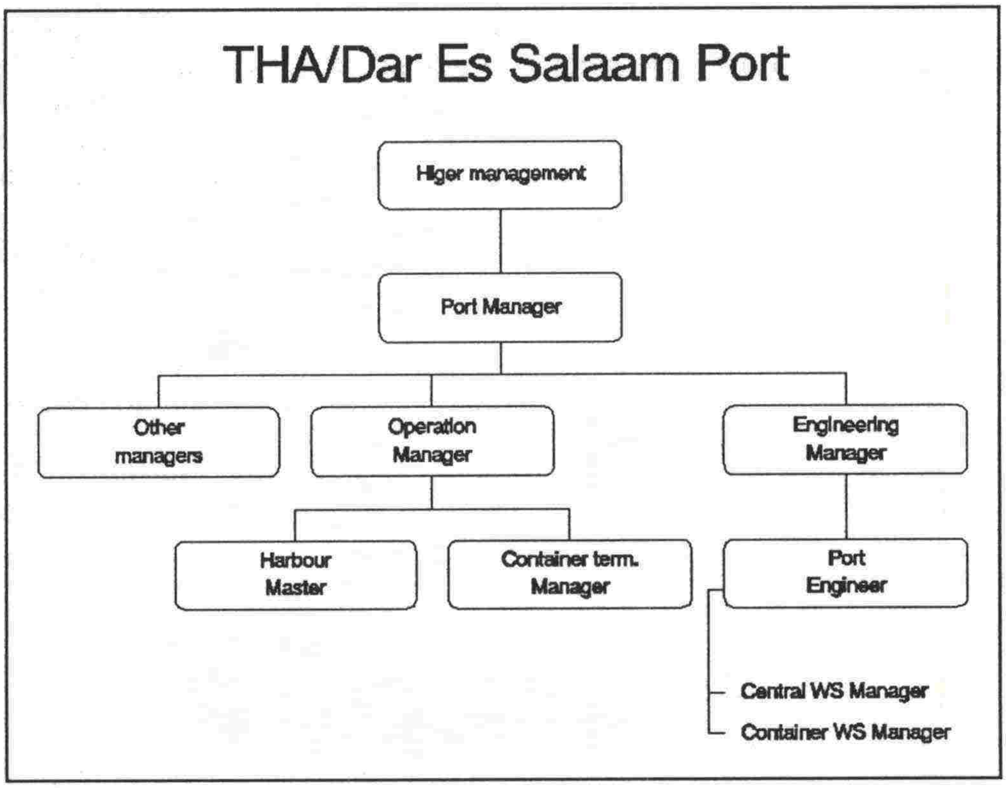
- The growth of the total traffic tonnage and the proportional growth of the container traffic (ca. 55% by the end of 1993).

- The growth of the number of containers to approximately 80000 TEUs (1993), the need for additional equipment capacity will arise.

- The economic life span of the equipment will end during the second half of the 90's. The aging of the machinery and the growing usage of it will cause a growing need for maintenance.

1.2 The Maintenance Organization

In the organization of the Dar Es Salaam port there is a separate maintenance organization, part of it is the container terminal workshop. The highest responsibility belongs to the Director General (Picture 4). As his subordinates, the Port Manager and the Assistant port manager of Engineering are both responsible for the functioning of the maintenance work. The next step in the organization is the Port Engineer who is the operative director of the maintenance entity. The managers of the maintenance units will report to the Port Engineer. /4/



Picture 4 Port Maintenance Organization

The maintenance units are :

-Central work shop
*The Satellite work shops, A,B,C

-Container terminal work shop
*The work shops of the inland terminals
UBUNGO (tire works)

KURASINI

The maintenance department has been separated from the Operation in the port. In the container terminal this causes problems in the equipment cost follow up and makes it unclear who controls the equipment. It would be natural to follow the container terminal activities in whole, in which case the work shop would be an integral part of the container terminal. The maintenance department which in this study is represented by the Container Terminal Workshop will later on been referred to as the Maintenance.

1.2.1 Maintenance Strategies

The international ports are using different maintenance strategies. In some ports the maintenance system is the same for all equipment. Other ports have different maintenance systems for different equipment and there are even ports, that seem to have no systematic maintenance at all. Usually a has chosen from the following maintenance strategies or a combination of them :

1. **Preventive maintenance** corrects the problem before it causes an actual break down.

2. **Corrective maintenance** corrects the problem after the break down.

3. **Designed-out maintenance** tries to find a means of minimizing the need for maintenance and the risk of break downs.

Preventive maintenance is based on the statistical life span of machine parts and the condition follow up of equipment. The statistical life span and the maintenance intervals are defined in the manufacturers manuals, which give the running hour after which certain parts should be changed. The benefits of such a system are :

- Unambiguosity
- An easy follow up
- Simple maintenance planning
- Easy maintenance schedule planning for all equipment

This system makes it possible to achieve a satisfactory level of maintenance with a minimum input on follow up and maintenance planning. The system has its cons. The service intervals in the manufacturer's manuals are averages and they don't take into account the different environments. This might cause some parts to be changed too soon, whereas rough usage might cause break downs before the scheduled maintenance. Furthermore, especially in developing countries, the maintenance personnel might have difficulties in reading the foreign language manuals.

The condition follow up system is based either on using probes to detect abnormal heating, resonance and acoustic emission or on the observations of the equipment operators and maintenance personnel. The idea is to estimate when a certain part should be changed or when the whole equipment should be maintained. The system tries to optimize the usage of machine parts. The part is not changed before it is worn out. This system demands well trained maintenance personnel and well chosen follow-up components. If the follow-up is not able to spot the problem before the break down, the system has failed its purpose and the equipment will arrive at random for service.

Corrective maintenance can't be considered a real maintenance strategy because every port has to be prepared for break-downs. However, if the maintenance manager decides to begin maintainance after break-downs, this strategy can also be possible. The corrective maintenance is usually an unwanted situation which is brought upon the port when :

- The work load of the workshop is so great that there is no personnel left to keep up with the preventive maintenance. This is usually the case when there is a lack of skilled personnel in the ports.
- There is no equipment follow-up program or the follow up is so poor that it isn't possible to keep track of the usage let alone the condition of the equipment.

Corrective maintenance is applicable for such cheap parts or devices, which have an unpredictable life span and which are quick to change. It's not worth while designing a maintenance schedule or a follow up for them. In general it is much cheaper to prevent a break down than it is to repair one.

Break-downs cause additional costs both for the Operation and for the Maintenance. The Operation probably has to hire extra capacity to make up for the equipment which is down. During the peak hours extra capacity is not necessarily available because the need for equipment is the same for everyone in the port. The Maintenance department may have to work overtime to repair a key piece of equipment or the break down might have caused damage to other parts as well. These additional costs will be transferred to the customers of the port and make the use of the port less attractive.

Design-out maintenance can also be seen as a type of quality thinking. Its purpose is to expand the life time of the equipment and to cut down the number of break-down causes. This way the amount of maintenance work will continuously decrease. The goal is to make the maintenance unnecessary.

In the most simple design-out maintenance system, the original parts of the equipment will be replaced with more durable parts. A wider view into design out maintenance covers all affected parties in the port from manufacturers and purchasing organizations to operators and maintenance personnel. These parties in co-operation will find out the environmental causes for break downs and redesign the equipment accordingly. The number of different models of equipment is decreased, in order to minimize the spare part stores and the need for training of the maintenance personnel.

An example of design-out maintenance can be found in Germany in the port of Bremerhaven, which traffic in 1982 was 800.000 TEUs. The port was then in for major investment and it was decided to analyze the collected maintenance data from the last 15 years. The aim was to find out the most suitable maintenance strategy and the best equipment to invest in. A work group was founded under the port director. According to the work groups suggestions, the following improvements were made: /6/

- The chains of the lifting equipment were changed with more durable ones and the chains were fitted with automatic lubricating systems. This tripled the life time of the lifting equipment.

- The break-downs of straddle carrier frames were analyzed which led to improvements in design and the typical failures decreased.

- All motors were standardized and changed to air-cooled units during a scheduled major equipment service.

The total impact on maintenance cost was significant because 44 % of service costs were calculated to consist of salaries. The time between break-downs grew longer and the service time shortened. This resulted in better economy. In addition to technical improvements the work group was able to create good relations with the equipment manufacturers and suppliers and good co-operation between the different departments in the port. The work in the port became more efficient, for example, the delay between a service request and the start of maintenance shortened.

1.3 Equipment

GENERAL:

The type and number of equipment form the basis for the planning of the logistics in the port. Before procuring the equipment, there is a optimization problem to be solved involving variables like the traffic volume, the carrying capacity of the container storage area and the piers and the amount of finances for investments.

The need for certain equipment can be calculated from the traffic volume and the availability of the equipment. The productivity of a piece of equipment is defined by, the number of containers that can be handled with it in a defined time limit. The availability of the equipment is the percentage of the total number of units of equipment which can be called to service at any specific time. The remaining equipment is most probably down due to either scheduled maintenance or break-downs.

Suppose that the nominal need for a certain group of equipment, taking into account the traffic and productivity, is 10 and the availability is 70 %. The total number of units of equipment can then be obtained by dividing the nominal need with the availability, which in this case gives 15 units.

The equipment can be categorized as follows :

- LIFTERS

  * gantry cranes

  * mobile cranes

* others

- LIFTER-MOVERS

  * front end loaders

  * straddle carriers

  * others

- MOVERS

  * terminal trucks/highway trucks

  * others

There has been much development in the field of container handling equipment and the naming conventions given to the equipment have not yet been standardized. The names of types of equipment in the following list are either commonly used or manufacturers' product names. The realms of the equipment categories are far from defined and there are machines which can belong to two groups. The equipment that manipulates the container stack define also its structure, that is, how many containers high and wide the stack can be. The stack can have a step like or a rectangular structure.

DAR ES SALAAM :

The main equipment in the port of Dar Es Salaam can be categorized as follows :

LIFTERS

- **The loading and unloading of the ship**

2 pcs Kone SSG (Ship to Shore Gantry crane) a rail mounted crane on the pier.

- **The loading and unloading of the train**

1 pcs RMG (Rail Mounted Gantry crane)

LIFTER-MOVERS

- **The container stack handling**

5 pcs Valmet RTG (Rubber Tired Gantry crane)

- **The moving of export containers**

2 pcs Valmet 42 ton FEL (Front End Loader)

(1 pcs UBUNGO)

2 pcs Lansing 42 ton FEL

To be able to handle containers the equipment, is equipped with spreaders which make it possible to lift the container from the top side.

MOVERS

- **The moves between the different handling places**

12 pcs Sisu HT (Highway trucks) with trailers

15 pcs Sisu TT (Terminal tractor) with trailers
(plus 5 pcs UBUNGO)

- **Other functions (handling of empties etc.)**

2 pcs Lokomo mobile cranes,

12 pcs 2,5 ton and 1 pcs 16 ton fork lift trucks

In addition to this equipment the stevedores and the shipping agencies have their own equipment which they can use regardless to the availability changes in the port.

1.3.1 The Equipment Usage

The equipment in the port of Dar Es Salaam is owned by the Tanzanian Harbours Authority. The Harbours Authority is responsible for the equipment and it sells the stevedoring services to the shipping line agents. The loading plan is made by the ship arrivals and the available equipment is allocated to the shift foremen accordingly. The equipment is controlled by the foreman to whom it is allocated.

Arisal of bottle necks corresponds to the ports work load. The transport chain has to be viewed as an entity. The efficiency of the handling between the ship and the berth might seem to be the most important factor, but this is not necessarily the case when the complete transportation system is considered. While the capital costs of the SSG-cranes are the highest, it is natural to demand an efficient usage of them. It is however not enough for the customer that the containers are quickly unloaded from the ship, they must also be smoothly delivered to their destinations. The port customers are invoiced by a fixed tariff for every unit.

The transportation chain starts with the SSG:s, which load the containers on the waiting tractor trailers. The importance of SSG:s is emphasized when the port tries to offer the shippers effective loading and unloading services. For the shippers it is important to minimize the loading time because of the high running costs of the ship. A late arrival of the ship to the next port might cause extra waiting time due to congestion in the port or a low tide.

The break-down of SSG:s doesn't usually stop the traffic because many ships have their own cranes for container handling. The efficiency of the ship cranes differ and is usually lower than that of the SSG:s. From the pier the containers are moved on the trailers to the RTG-cranes, which will place the containers in the container stack. From the stack the containers are lifted back on the trailers by the RTG:s and are then moved out from the port through the customs. The traffic out of the port is handled either by trucks or by train.

The congestion of the container stack lowers the productivity of the RTG:s, because the number of moves per container will increase when other containers have to be moved aside. Optimal utilization of the container stack is 70 % of the storage capacity. Most of the imports move through the stack and that's why a short dwell time is demanded. Customs procedures cause some extra moves for the RTG:s, when the container is taken out of the stack for inspection when after the paper work is done.

In the loading area, the export containers are lifted with front end loaders on to the trailers. The tractors take the trailers to the pier where SSG:s or ship cranes lift the containers on board. The capacity of the front end loaders will not be sufficient if all tractors are inoperative. This is however not probable with the current number of tractors and trucks. The export traffic is very dependent on the front end loaders and the forwarding agents usually rely on their own equipment.

The shortage of tractors and trucks slows down the traffic between the different loading areas in the port, which causes the containers to pile on the pier and in the container stack. The piling of containers on the driving lanes increases the risk for accidents. The productivity of the trucks is affected by the fact that the transport of one P/P container to Ubungo for unloading takes approximately two hours. /7/.

1.3.2 The Follow-up Variables

Availability, Utilization and Productivity are the variables used for the equipment follow-up. The time factors defining these variables are.

- **Planned total hours.** The workable hours. This means for SSG:s part that the SSG is beside a ship during a work shift and that the ship is ready for loading.
- **Technical downtime.** Part of planned total hours during which the equipment isn't available.
- **Idle hours.** Part of planned total hours during which the equipment is neither working nor down.
- **Working hours.** The planned total hours subtracted by the idle and the downtime.
- **AVAILABILITY)**

$$\frac{\text{(Planned hours -(idle + downtime)}}{\text{Planned hours}}$$

- **UTILIZATION**

$$\frac{\text{(Working hours)}}{\text{Planned hours}}$$

- **PRODUCTIVITY** Net productivity, which measures the handling efficiency during the working hours.

$$\frac{\text{(Number of handled containers)}}{\text{Working hours}}$$

The following target figures are set in the FINNIDA project:

TARGETS for the 1990-1993					
	*1989	1990	1991	1992	1993
Availability					
SSG	75	80	85	90	95
RTG	71	75	80	85	90
RMG	95	90	95	95	95
FEL	****	75	80	80	75
TT	****	75	80	80	75
HT	80	85	90	90	85
Utilization					
SSG	39	55	63	69	74
RTG	37	42	45	50	55
RMG	26	45	48	52	55
FEL	****	50	55	58	61
TT	****	40	45	50	55
HT	25	30	40	45	50
Productivity					
SSG	11	11	13	15	16
RTG	7	8	9	9	10
RMG	6	7	8	9	10
FEL	****	7	8	9	9
TT	****	3	3	4	4
HT	1	1.5	2	2.5	3
*Actual figure					

The FINNIDA project document defines the utilization ranges as **LOW** for 60 %, **MEDIUM** for 70 % and **HIGH** for 80 %. It is not economical to achieve a 100 % utilization. Together with the utilization of the working time, which have the corresponding values of 50%,67% and 75%, the total annual container handling capacity can be calculated.

Calculating with the medium values the current total annual handling capacity is approximately:

EQUIPMENT	TEU
HT(P/P-handling)	120.000
TT	100.000
RTG	80.000
SSG	80.000
FEL	65.000

With the current, traffic the availability of SSG:s has been fairly high. Their utilization, however, is very low which is the case for all container equipment. The low utilization of equipment may be an indicator of operational deficiency of using the available equipment. This can lead to situations where the crane unloads the containers faster than the trailers are able to assist. /7/.

1.3.3 The Cost Follow-up

The development projects have until recently been concentrating on improving the practical side of both port logistics and maintenance work. In the current phase of the container terminal project, the need of a follow-up system for costs and activities is becoming more and more clear. The goal of a follow-up system is to support management and to make it possible to evaluate the overall economy. The follow-up should also make it possible to see the effects of the current projects and to reveal problem areas for new projects.

In the lack of follow-up information the operative costs are estimated using the following criteria./2/

- 20 % is added to the procurement prices to cover the costs of freight and erection of the equipment.

- The economical lifetime is estimated to be 15 years for the SSG and RMG, 10 years for the FEL and 8 years for the other .equipment. On these grounds the investment is divided as write offs with a 10 % interest. The investments allocated to the piers and the container stack are not included in the write-offs.

- The annual service and maintenance cost is estimated to be 2 % for SSG and 5 % for the other equipment.

	The cost of Container terminal equipment					
		x1000 USD (1989)				
	SSG	RTG	TT+ Tr	HT	FEL	RMG
pcs	2	5	15	12	1	1
purchasing price	12000	7400	2200	195 0	420	3600
	***	****	****	*** *	***	****
write-offs	1400	1235	385	340	70	420
service	240	370	110	95	21	180
salary	40	40	30	25	4	10
fuel	60	75	135	40	10	20
total	1740	1720	660	500	105	630
UNIT COST	870	344	44		105	630
	****	****	****		***	****
Pier	TEU	Unit cost	USD-/TEU		TOT	Tariff
SSG	36000	870	24		29	69,35
Stack						
RTG	9000	344	38			
FLT	9000	105	12			
TT	8440	44	5		55	23,75
HT	****	****	****	***	**	****
USD Total			79		79	93,1

The handling costs have been divided by the annual traffic for the purpose of comparing the costs and revenues. According to this calculation the total operational handling costs seem to be covered by the tariff income while leaving something for investments. The costs of the container stack (RTG-FEL-TT) are clearly greater than the handling tariffs. It seems that the setting of tariffs doesn't quite follow the division of the costs.

The calculation presented here is however an approximation and note that the estimation of the maintenance cost can be misleading because the equipment used in the port are new models and there is a lack of knowledge and experience concerning the amount of maintenance that should be done on them. The lack of systematic follow-up leaves some doubt to the lifetime expectations. A shorter equipment lifetime will increase the now already high write off costs.

In the current situation the responsibility of cost follow-up is on too high of a level and the costs of the container terminal will disappear in the overall costs of the port. In the operative level, where the costs are created, follow-up systems for collecting costs don't exist. A main problem here, is that the costs of the Maintenance are not taken into account. From the Operations point of view a lot of costs are ignored.

The activities should be divided into cost categories in order to develop the cost follow-up. A natural division would be to separate the activities into Operation and Maintenance. This way the total maintenance costs could be calculated and divided among each equipment group as an overhead on top of the running costs.

The next step would be to create an equipment pool, which would let capacity either to the Operation or straight to private stevedores. This would be an easy way to combine the economy and profitability with the activities. The pool would also simplify the questions of equipment ownership and control. This would direct all costs to one place. Whether the pool should function on zero profit or as a profit center is a key question. In case of zero profit the profit making and the marketing responsibility would be in the hands of the Operation.

2 THE CONTAINER TERMINAL WORKSHOP

The task of the container terminal workshop is to keep the equipment availability on the target level and to plan service schedules in order to ensure that a sufficient number of equipment be in operation at all times. In order to be able to lay out the service plan, the workshop must have an equipment follow-up system.

In the port of Dar Es Salaam the preventive maintenance is based on the running hours. The running hours are collected weekly by the workshop personnel. When a piece of equipment is due for service the workshop asks for the equipment from the Operations personnel.

2.1 The Workshop Organization

The workshop organization in Dar Es Salaam is divided into a Mechanical and an Electrical section (Picture 5). The resident engineers are in charge of these sections. The engineers receive and authorize the work and also plan the service tasks. Together with the super-intendants they authorize removal of spare parts from the store. Senior technicians function as foremen and they usually fill in the work orders.

The task of the Planning group is to plan the maintenance schedule and to do a cost follow-up. The follow-up of the maintenance schedule is done by the group with the help of a maintenance chart. On the chart there is a horizontal calendar and a vertical list of equipment. The scheduled services are presented by attachable bars of different colors. There is a plan to store all equipment history cards and work orders at the Planning group. For cost follow-up the group cost summary cards for every piece of equipment. The importance and development of the Planning group has been ignored in the project while the development has been directed to enhance the engineering skills.

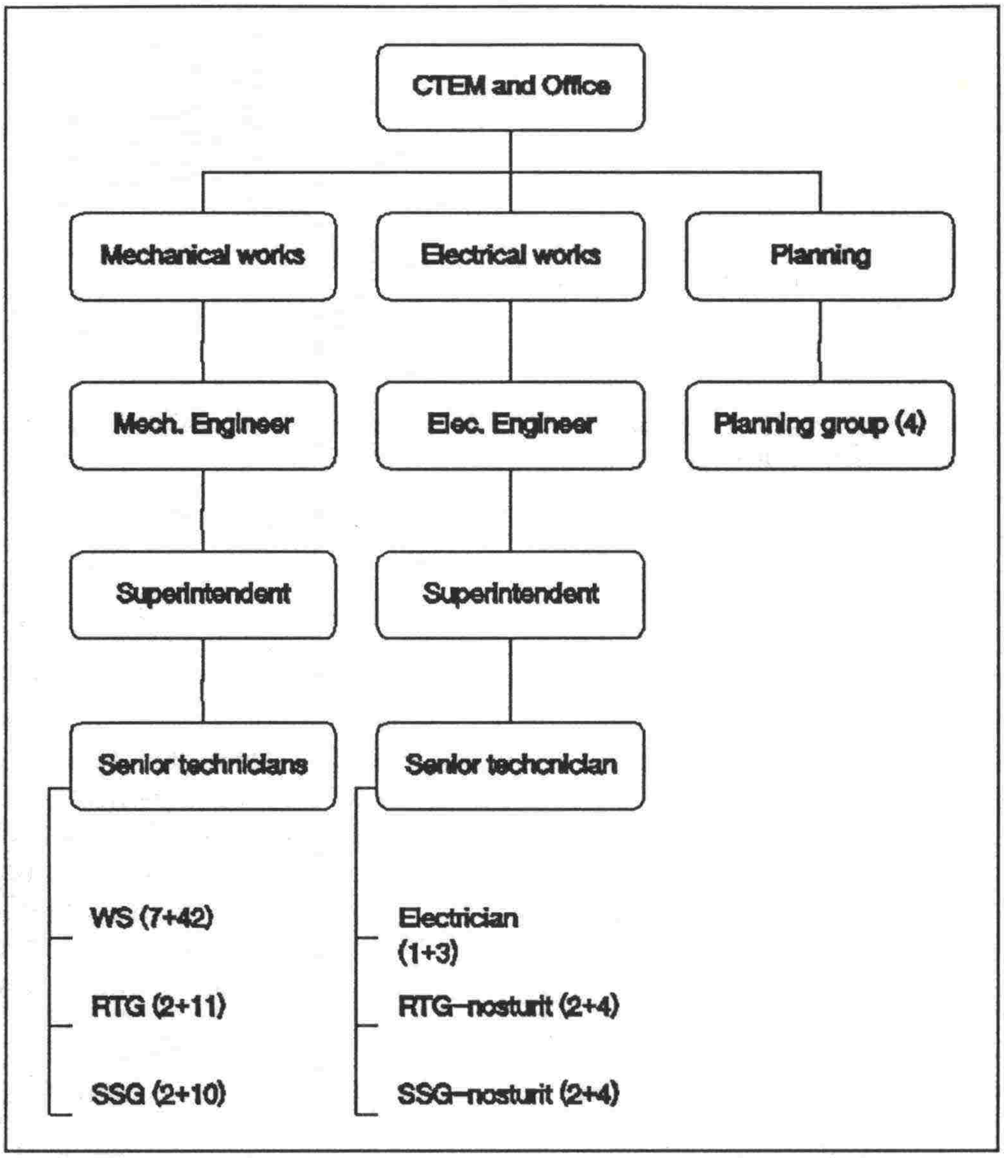
2.2 Connections Between Maintenance and Operations

The Maintenance should in constant co-operation with the Operation because that's the only way to maintain a overall profit. It would make sense to service the equipment at times when they are not needed or in use. The Operation has a usage plan and that monitors the usage of equipment, when analyzing the utilization figures it is evident that there is plenty of idle time for service.

The basic ideas of overall profitability are:

- Maintaining the service level. The Operation must have a sufficient capacity at all times.

- Maintaining the technical performance level, i.e. scheduled maintenance should be done in time and correctly to maximize the economical life time of the equipment.



Picture 5 Workshop Organization /2/

The co-operation between the Maintenance and the Operation should be improved in order to achieve a flexible servicing scheme. This puts a pressure on the maintenance planning system. The Maintenance should be able to estimate the service times and to optimize the usage of its capacity in order to make use of the operational idle time.

In practice the Maintenance is seen more as a nuisance, the will to co-operate doesn't exist. There are few formal contacts between the two departments. In the port of Dar Es Salaam contacts are made trhough:

The planning meetings

A planning meeting is held daily. In the first meeting of the week the preliminary plan for the whole week is presented. In the other meetings only the next two days are discussed.

The work shop should get the information of the ship arrivals and the possible changes in the arrivals and their effect on the need for equipment should be discussed in the meetings. In the meetings a workshop representative, who has enough knowledge of the current work load and the authority to change the maintenance schedules, should be present. The aim is to fit together the schedules of the Maintenance and the Operations.

The information exchange between departments :

The Operation sends the equipment to be serviced with a service request (Appendix 5), of which one copy is left at the Operation. The request is returned with the equipment. This is currently the only document moving between the two departments. The request make it possible to keep track of the equipment currently in service. The usage of the request shows how fast the information of the break-down reaches the Maintenance and how fast the equipment is returned in service after the maintenance.

3 EMIS (ENGINEERING MANAGEMENT INFORMATION SYSTEM)

The combination of the activities aimed to collect and file information for the management reporting is called the engineering management information system (EMIS). With the help of EMIS the management should be able to :

- define the service annual and monthly schedules to support the terminal in achieving its targets.

- control the utilization of manpower to guarantee a sufficient work force for the most urgent services. The utilization and the knowledge of the personnel should be followed.

- follow-up the actual figures and to compare them to the budget. It should be possible to find the explanations to the deviations.

- give recommendations for the renewal or the scrapping of the equipment.

- follow the usage of spares and put priorities on spare purchases depending on the financing situation.

3.1 Dar Es Salaam, the Current Situation

The current situation of the follow-up in the port is poor. The current system has been developed from an old English system and it hasn't been modified to meet the modern needs. The environmental factors have changed after the system was designed. The container traffic has grown rapidly after the mid 80's and the container terminal activities set new demands on a follow-up system. The old system is also too massive because it was designed as part of an overall information system, which doesn't exist anymore.

There are several breaks in the original information chain of the port. The system was originally designed to run in the main computers of the harbour authority. The computers don't function due to a lack of maintenance and technical support. Computer time has been bought from other big organizations like the TAZARA (Tanzanian Zambian Railroad Authority) to be able to keep the storing and personnel systems in operation. In practice the information channels between the administration of the port and the operational departments are inoperative.

The vital information of the port should be defined after which the information system can be simplified and the information interfaces between the organization levels and departments can be defined. The information system can at first function manually and then be transferred to computers.

The development of the information and follow-up systems is at present done in the low levels of the organization. Strong development has been done in the Operation, which collects information about equipment productivity, utilization and availability. Information about container traffic (exports, imports) is also collected and the operation has developed a computer program with a PC data base (Borland: Paradox) for the follow-up and invoicing of the empty containers.

The computer program of the Operation is part of OMIS (Operation Management Information System), which development is presently taking its first steps. Further development will compel the information islands of the Maintenance and the Operation to converge and at that time the need for information exchange will become inevitable. A system based on PC-computers could be developed to an equipment follow-up system which would keep track of both the utilization and the service plans. The technical implementation could either be based on information exchange on floppy disks or over a small local area network.

The reports produced by the Operation are integrated into the port information system post development by the Board of Directors. The development is done without the support of the port management and only the final work is presented. The management doesn't commit itself to the development work and it can easily either accept or abandon the final systems.

The departmental need for information should be defined in the departments, but when the overall guidelines are missing the organizational needs can't be taken into account during the development. This will lead to collecting the same information on different levels of the organization, which is unnecessary. The collection of data should follow a systematic hierarchy. The basic data should be collected by the lower organizational levels and be summarized to suite the needs of the higher levels.

The existing workshop information system collects data, that the workshop doesn't need or which could be summarized from basic data if it were systematically collected. The incoherence of the system and the lack of a clear idea behind it makes it impossible to properly analyze the data let alone draw conclusions based on it. The main problems are :

- **Lack of cost information.** Making a reliable budget or even following one is not possible.

- **Equipment follow-up.** The maintenance history doesn't refer to work orders and job cards which means that the information about what specifically has been done to the equipment and by whom is missing.

- **The work force and work follow-up.** The existing system doesn't collect data on all work that takes place. This makes it difficult to estimate number of workers needed. The poor documentation of the works make it impossible to calculate standard task times, find out topics for training or to estimate the quality of training.

- **System incoherence.** Presently forms are filled both by technicians and the clerks in the Planning group. The maintenance history cards and the work orders are filed in several different places.

- **The reliability of data.** The data which is filled in the forms is usually not reliable. The main cause for this is that collecting data seems unimportant and the meaning and the usage of the forms is unclear.

3.1.1 The Forms

There is a multitude of forms in the workshop. During this research 34 different forms were collected. Four of the forms were cost summaries for collecting the maintenance and fuel costs for each group of equipment. The filling of cost summaries has been partial because the information on spare part prices are usually missing.

Most forms were for taking items out of the stores. These forms consisted usually of three to five pages. Different forms existed for getting items from the terminal workshop store, central workshop store or for purchasing the items outside the port.

The set of forms is not systematic. Information which belongs together is gathered with different forms. The Work order for instance contains only the number of workers and there is no identifier. A separate Job Card includes the information of the specified works given to the workers. Neither of these forms have a reference to the other and the information about who actually serviced the equipment is lost.

Collecting data has in many cases become an end in itself which doesn't serve the needs of the port or the workshop but goes back to the days of a working overall information system. The way the data is presented probably has its roots in the way the programs were designed at the port computer center.

3.1.2 The Statistics

The foundation of the workshop information system is the Work order /9/. A Work order form exists in the workshop and the data from the Work order should be transferred to the maintenance history cards. The work number should be written as a reference into the history cards. The cost cards should also be filled.

Only the total maintenance costs should be written into the history cards, which would then contain the cumulative maintenance costs of the equipment. This would then indicate if an overhaul on a piece of equipment would be economical.

The only reliable statistics and planning is the scheduled maintenance, which is followed up with a table on the wall. Different levels of service are presented in different colors. The short term planning of maintenance works is however not working.

When equipment is due for service the Operation is asked to release it for service. No follow-up on the work load of the Operation is done, which means that the workshop doesn't necessarily get the equipment for service as planned.

The information system is in a situation where development is vital if the workshop management wants to make informed decisions instead of guesses. The best approach would be to redefine and simplify the current system. The present statistics are so poor that it enables unauthorized absences, the disappearances of tools and the usage of materials to unauthorized works.

3.2 The Follow-up in Finnish Ports

3.2.1 The Port of Rauma

The Port of Rauma handles bulk, oil and container cargo. The main areas are the export of paper (over 60 % of export) and the import of fuels and chemicals (approximately 50 % of the import). The total traffic of the port is less than three million tons (2,6 Mt tons in 1990) of which a small part moves in containers (16000 TEU, 0,14 Mt in 1990). The port could traffic wise be compared with Dar Es Salaam (total traffic) and with Beira or Maputo (container traffic).

The city of Rauma owns the berths, some warehouses and a few cranes. The city collects fees from the usage of the berths. The operative activities and maintenance of the equipment is handled by Rauma Stevedor Ltd, which is part of the Yhtyneet paperitehtaat corporation (The United Paper mills Ltd).

The equipment consists of 130 pieces of motorized handling equipment. The equipment is grouped as: Movers (15 %), Lifter-Movers (70 %), Lifters (2 %), Others (13 %). Most of the Lifter-movers are small, including less than 10 ton fork lift trucks, which are fitted with clamps for handling paper rolls or forks for handling dry cargo. For container handling there are two specialized 40 ton units.

The workshop is basically a service center for the Operation. The port functions usually in two shifts but in the evening the workshop has only a standby group of two servicemen (total workshop personnel 1+16).

Stevedor Ltd. tries hard to move the work planning and follow-up to computer systems. Both the Operation and the Maintenance can read and update the main data base with their PC-computers.

Problem areas in the port information system.

- The equipment resource follow-up is weak. The work planners don't have information on which equipment is currently at the workshop.

- Getting equipment in for service on time doesn't usually occur. Either the service requests don't reach the work planners on time or the equipment is needed for work.

- The maintenance costs aren't followed separately and they aren't used when the equipment running costs are calculated. This way there is no information about the profitability of the equipment.

- The equipment can every now and then "disappear" when the foreman of the shift or the operator doesn't remember to report that the equipment is delivered to the workshop for service.

- Although the computer system is already fairly old (6 years), it still functions mainly as a storage for basic data. The effective usage of the system and the reporting is still under development. The integration of the system is low.

The connections between the Operation and the workshop is dependent on the workshop liaison person, who is in constant radio contact with the Operations. An equipment resource program will bring enhancement to the follow-up. The service requests will then be fed into the data base with the information about the estimated service time.

EMIS is part of the overall computer system and it prints out the Work orders and a list of equipment which will soon be due for service. The preventive maintenance system is based on the fuel consumption. The fuel consumption has been found to correlate well with the actual working hours.

The fuel consumption takes into account the difference between idling (in wintertime) and actual handling working. In this way the equipment which has done more work will come in for service sooner than the ones that have been idle.

Preventive maintenance used to be based on running hours but the data collection was problematic. Problems were caused by hour meters that were constantly breaking down, difficulty in collecting data and the unreliability of operators reports of the running hours.

The service intervals are calculated in liters. Intervals are based on the recommended running hour interval of the manufacturer, which is then recalculated into fuel consumption. The consumption follow-up is done with a computer connected to the central fuel delivery station.

The service types are A to G, which consist of different tasks for different groups of equipment. The service types follow a certain pattern defined for each group of equipment. One pattern could be ABACABAD, where every third service is a more profound one.

Following data can be fed into the system :

- Costs of the consumed spares, materials, tires and the used man hours for each equipment.

- Maintenance history data. The starting times of the services, work numbers and clarifying text about the maintenance.

- Updates to default data (maintenance tasks) and inserts (new equipment).

- Consumption and purchase of spares (storekeeping).

- The operators working hours are fed by the personnel department for calculation of the salary. The working hours are not the same as the equipment running hours so they can't be used in division of the maintenance cost.

The biggest shortcoming of the system is that of poor reporting. The maintenance history is slow to browse trough and the total maintenance time is not documented. The workshop is still not tied with the overall planning of the port. In general the system has great potential and it standardizes the practices in the port. It seems that the support of the management is lacking because there is no general goal for the system development. The leading principle is yet missing.

3.2.2 The Port of Helsinki

The port of Helsinki has the biggest volume of imported general cargo, the greatest number of container traffic and it is the third biggest export port in Finland.The total traffic in 1989 was 8.2 million tons. Of the general cargo over 40 % was containerized (246 145 TEU in 1989), when including the trucks and trailers 95% of all traffic moves in large units. There is little handling of other than large units. Other handling equipment is kept only to provide the customers full service.

The Helsinki Harbour Administration is a company owned by the city. Its activities include traffic planning, crane services and some storage of goods. The organization is divided into five sections under the harbour master :

- ADMINISTRATION AND ACCOUNTING

- TECHNICAL SECTION

- SHIP TRAFFIC CONTROL CENTER

- EASTERN PROFIT CENTER

  *THE PORT OF SÖRNÄINEN (3,2 Mt, 88 000 TEU)
  *LAAJASALO AND HERTTONIEMI OIL PORTS

- WESTERN PROFIT CENTER

  *WEST PORT
  (2,7 Mt, 158 000 TEU)
  *EAST PORT
  (0,9 Mt, 8000 TEU)

The Operations in Helsinki have been divided between the city company and a private company. The city company takes care of the ship to shore activities whereas the stevedoring activities are handled by Finnsteve Ltd. In the West port the company has 4 cranes, of which one is capable of multiple handling. There are 28 workers of whom 3+7 are workshop personnel. The crane group works in two shifts, which enables a 50 % utilization of the cranes. /3/

The Lifter-Movers are owned by the stevedoring company except for some 45 warehouse fork lift trucks (of 1,5-6 tons). Finnsteve offers its customers a total package of handling services and then buys the crane services from the city company. Finnsteve has a fairly big workshop, where all its container handling equipment is serviced. The container handling equipment consists of straddle carriers (6 pieces), fork lifts and front end loaders (97 pieces ranging from 2.5 to 55 tons) and trucks with trailers (38 pieces).

The follow-up system is an application which is run on Finnsteve's computer. The city company and the customs officials have access to the container information. The co-operation between the different companies and authorities seemed to be smooth.

The city company is divided into profit centers. Monthly reports show a result calculation of all incomes and costs which are divided between investment and running costs. The interests of loans are divided into those profit centers which have used loans to pay for their investments.

All services have internal prices based on the cost price principle. This enables the "hiring" of manpower from for example the Sörnäinen port. The salary and the social costs will be directed to the department which is hiring and they will show up on the next months result sheet.

An incentive will be paid for a good result. The incentive is based on a comparing the results of present and previous quarter years. A proportional development in the better direction will give a incentive which is between 0-10 % of the monthly salary. Affecting the profitability will also affect the personal income. The incentive scheme has had positive effects on the work motivation and the number of absences have decreased.

The preventive maintenance system is based on the combination of the running hours and the amount of container traffic. The services are scheduled for idle times. This is possible because of rather fixed ship traffic. The maintenance department has a list of the all scheduled ship arrivals and has good co-operation with the traffic center. The maintenance is planned accordingly. Co-operation with the traffic center makes it possible to inform them when there are crane break-downs and to make suggestions to use another crane and berth for the incoming ships.

The city company's maintenance follow-up is based on a manual system because of the small amount of equipment. The cost follow-up is however fed to the computer system. Service checks are made daily by a mechanic. The foreman will run a more detailed check every quarter year. The Administration for the control of electrical equipment will make a once a year thorough check. The maintenance cycle comes to a peak in May. During the summer, when there is a lot of traffic, the services are avoided. During winter, services are done if the weather allows it. The weather especially affects maintenance which includes welding.

The use of incentives has made it possible to transfer part of the maintenance work to the operators (greasing, cleaning and painting). The main responsibility still lies on the workshop. The manufacturers maintenance services are also used because of the lack of specialized tools. In general, all maintenance is done with their own resources while the cost price of the hour is usually half of the manufacturer's service price.

3.2.3 The ports of Kotka and Hamina

The ports of Kotka and Hamina are connected through Steveco ltd., which has a monopoly in stevedoring business with its main office in Kotka. The cities are landowners and they get their share of profits through the harbour tariffs. In Hamina, the city still owns a few ship to shore cranes, but it has decided to give them up.

The dry cargo berths in the Kotka port are divided between the Hietanen port and the Main port. The container traffic moves through Hietanen. In 1990 the stevedored cargo was 7,6 million tons, of which the export accounted for 67 % (5,1 Mt) and the import 25 % (1,9 Mt). The transit traffic was 8 % (0,6 Mt). The main export articles are paper (69 %) and timber (14 %). The main import articles are coal and chemicals for the paper industry. The total number of handled containers were approximately 60 000 TEUs (0,6 Mt) and they mostly contained imports. The volume of the container traffic is close to that of Dar Es Salaam, but it's still a small part of the overall traffic.

The equipment are divided into :

LIFTERS :

7 pcs Gantry Cranes

LIFTER-MOVERS:

Front end loaders and fork lift trucks :

12 pcs over 20 tons

79 pcs 10-20 tons

170 pcs under 10 tons

MOVERS :

48 pcs Trucks with trailers

28 pcs Terminal tractors

OTHERS:

24 pcs

There is a total of 386 pieces of equipment and a great number of accessories. The accessories are mainly spreaders for container handling and clamps for paper roll handling. The equipment is used both in Kotka and in Hamina and they are moved depending upon the traffic peaks. It takes approximately two hours to move a piece of equipment between the two ports.

There is no portal type container handling equipment, so there is no actual container stack. Containers are stored in rows at several locations. The container traffic has however been multiplied by six during the last seven years, so more efficient measures are soon to be considered.

The information system in the Steveco company is centralized. It consists of four Hewelet Packard HP3000 mini computers with 190 connected terminals and 180 printers. The company has also 52 PC-computers. The central computers will be renewed during 1992. In addition to the normal personnel applications, the central computers run customer applications like the invoicing and the cargo reservation programs. The cargo reservation adds convenience and speed between Steveco and its customers (the exporting paper mills and the shipping lines).

In the end of 1990 the company started using a resource control system which has been developed further during 1991. The control system is mainly a tool for the Operation. The system enables resource planning of the shifts including the equipment. The system should give the situation of the equipment and work force on a real time basis which makes it possible to use the resources efficiently. Driving orders for operators and work lists for the shift foremen are main system outputs.

The dividing of resources is done every day before noon in the Organizing center. The resources are divided by the requests from the night shift foremen. Work groups are formed, the equipment is allocated and the operators go to the parking area to get the equipment. If a particular piece of equipment is due for service it can be exchanged for another one in the parking area. The parking area attendant will feed the register numbers of outgoing and incoming equipment into the control system.

Steveco has two workshops in Kotka, one in the Main port and an other one in Hietanen. All equipment, which are not in use, is parked in the workshop parking areas. The Equipment department, to which the workshops belong, will charge the Operation for the use of equipment. The investment and the running costs are charged with a two level system.

The charge consists of a monthly base rent, which should cover the investment costs of the equipment. The base rent is defined by the monthly need of equipment, which the Operation defines. The other level of the rent is the hour rent, which is charged according to the planned hours fed into the resource control application. The computer application starts the calculation of the hour rent whenever equipment is allocated by the Organizing center. The purpose of the rent is to :

- Transfer the cost of maintenance and usage to the actual user, that is the Operation.

- Make the usage more efficient.

- Give the Operation a mathematical model for optimizing the number of base equipment.

Preventive maintenance is based on planned hours with a fixed 250 hour service interval. Planned hours don't measure the actual usage of the equipment because the Operation doesn't always remember to free the equipment in time after the duty. This might cause too short service intervals. Steveco has been considering a similar fuel follow-up system to the one used in Rauma. The fuel distribution is already centralized.

Scheduled services are classed from 1 to 8. The odd numbered services are for overall checks and for changing oils. The services 2 and 6 are for changing filters and the services 4 and 8 are more thorough ones.

The actual internal invoicing has not yet started. The division into profit centers still isn't completely clear. The Operation is still reserving more capacity that it generally needs. The invoicing should make the Operation ponder the profitability of reserving the equipment. The preliminary follow-up revealed that the need for movers, with the current base need of 16, was on an average only 8. The Operation was paying the base rent for eight extra movers, which could have been used elsewhere.

The Operation pays a penalty fee (double hour rent) for equipment not included in the base number. The Equipment department pays a penalty fee (five times the hour rent) if it can't come up with the number of equipment the Operations has defined as its base need within two hours of an allocation.

If the Operation and the Equipment department both form profit centers, there are some flaws in the current system considering the overall profitability of the company. Unnecessary invoicing can occur if the Operation allocates equipment to nonexisting works when it knows that the Equipment department is short of equipment. The Equipment department can hire capacity from an third party equipment owner if the rent is lower than the penalty fee. Paying money to outside companies is hardly a wanted act and it would probably be more economical to pay for a possible overtime to repair allocated equipment instead.

The Steveco information system is an excellent tool for resource planning. However, it doesn't suite well as a workshop information system. The system offers some good services for the workshop like the possibility of exchanging already allocated equipment for another. This makes it easy to keep to the planned maintenance scheme. The maintenance history of the equipment can be fed into the system, but only as text so it's not possible to make statistical reports.

The workshop in Hietanen has started to develop a tool with the Paradox data base program for the use of the workshop foremen. The application would make it possible to follow the proceedings of individual maintenance works and the maintenance history of the equipment. The development has only started and the company is contemplating getting a mainframe system for the workshop follow-up. Considering the small size of the workshop activities a mainframe system seems too big for the task.

A mainframe package includes usually functions that are not needed but which are all the same paid for. Even ready made systems need tuning and additional development work which is usually very expensive. One thing that should also be considered is the development in the PC-computers. In the past five years the ratio of capacity and price have been increasing and any system plans which are not founded on recent figures should be remade. Systems created around PC-computers are becoming more and more attractive both price and performance wise.

A data network already exists in the port through which the workshops could get resource information and send back reports from their own information systems. The data needed on the higher departmental levels could be for example reports of the consumption of spares, man hours and absences. It seems that the study on the actual information needs of the different interested parties is undone.

3.3 The Test Follow-up Model

The problems in the Finnish ports seem to be the same as those in the developing countries. The co-operation between the Operation and the Maintenance is not working in the best possible way. The workshop is seen as a second rate department of the port and the work motivation is low in the workshop. The principles of Just On Time production has in Finland led to situations where some parts aren't immediately obtainable from the manufacturer and the waiting times can go up to several weeks. The need for equipment follow-up and preventive maintenance prevails.

The follow-up systems are very different in different ports. In Finland the systems are more centralized and Operation centered. It must be remembered that the systems have usually been developed before the rapid developments of the PC-computers.

The practical workshop work is more or less the same universally. The studied ports have chosen the strategy of preventive maintenance. The preventive maintenance is based on some variable that measures the usage of equipment. The maintenance work is documented in a work order and is partly summarized in the information system. The statistics include usually a follow-up of the cumulation of maintenance costs on a piece of equipment or equipment group.

Applying the strategy of a centralized system in the container terminal workshop of the Dar Es Salaam port is impossible. The PC based computer systems in the compared ports are on the other hand in an early development state and they aren't planned for the managerial level. The structure for an information system has to be constructed from scratch. For the test follow-up model the work order (Appendix 1) was renewed (Appendix 2) to meet the demands of the new system. The idea was to first concentrate on the main information and to simplify the system by cutting down unnecessary paper work.

3.3.1 The Follow-up Variables

The main activities in a workshop are the service and maintenance work. One crucial difference between a workshop in a developing country and a workshop in an industrialized country is the price level. The price level changes the cost structure. In developing countries the cost of the spare parts used in maintenance work is much higher than the cost of the manpower. The lack of well trained maintenance personnel still makes it important to organize the use of manpower efficiently, which is difficult to accomplish without a follow-up of man hours and maintenance personnel.

The work order is divided into four sections:

The Headline section individualizes the maintenance work and includes the reference information which makes it possible to later find the document.

Preparation and planning includes a break-down of the maintenance work into the main operations. The idea is to write down the daily time used for a specific operation on a half-hour basis. There is a special row to write down the dates and the total waiting times. The total Workshop hours are obtained by summing up the total hours for all operations.

The Working Staff section individualizes the workers by using their personnel number for every maintenance operation. The working hours are divided into Normal and Overtime hours (O/T). The total is the number of Man-hours used for the work.

The Material Expenditure section includes the spares and lubricants consumed in the different operations. The section includes the signature of the storekeeper (STO.SIGN) because the work order is planned to replace the forms for taking out items from the workshop's own store.

Here are the main variables of the Work Order (Appendix 2) :

- Number (the smallest data unit of maintenance work). The work number is currently divided depending on the group classification of the equipment. The form of the number is /xxx/yy/mm/nnn :

  xxx = The equipment group code (ex.SSG)
  yy = Current year
  mm = Current month
  nnn = The monthly running maintenance number.

- Machine,Part & no: The identifier of the equipment or part.

- Work description, given by the controller/authorizer.

- DATE, TIME IN(OUT)/The dates and times for receival and delivery of the work. The difference should be the WORK-SHOP HOURS taking into account the work shifts and holidays.

- METER READING The running hours/km's of the equipment

- OP/No /Operation number. Reference number for combining the materials and man-hours used in the same operation.

The workshop still doesn't have a fixed cost for a maintenance hour. That's why only the consumables have a cost column (Cost/SHS = Tanzanian Shilling). The man-hour cost is currently so low that it could almost be overlooked. The system must however be able to keep track of the man-hours because manual work is the key element in maintenance. If the basic salaries were to be changed, the system must be able give enough information for estimating the impact on the total maintenance costs.

The Harbor Authority's Accounting department has started to collect information about the man hours of all three classifications of workers. The Accounting department probably tries to determine separate mean costs for the different classes.

In the industrialized countries the workshops usually have one fixed price for the maintenance hour. Using only one fixed price is clear and it decreases the possibility of errors. This system could well be adopted in the container terminal workshop.

The mean price should include the overheads and the costs of the workshop administration. The mean time could be then defined as the weighted average of the salaries of the maintenance personnel. The price of the maintenance hour could be ratified annually during the preparation of the budget.

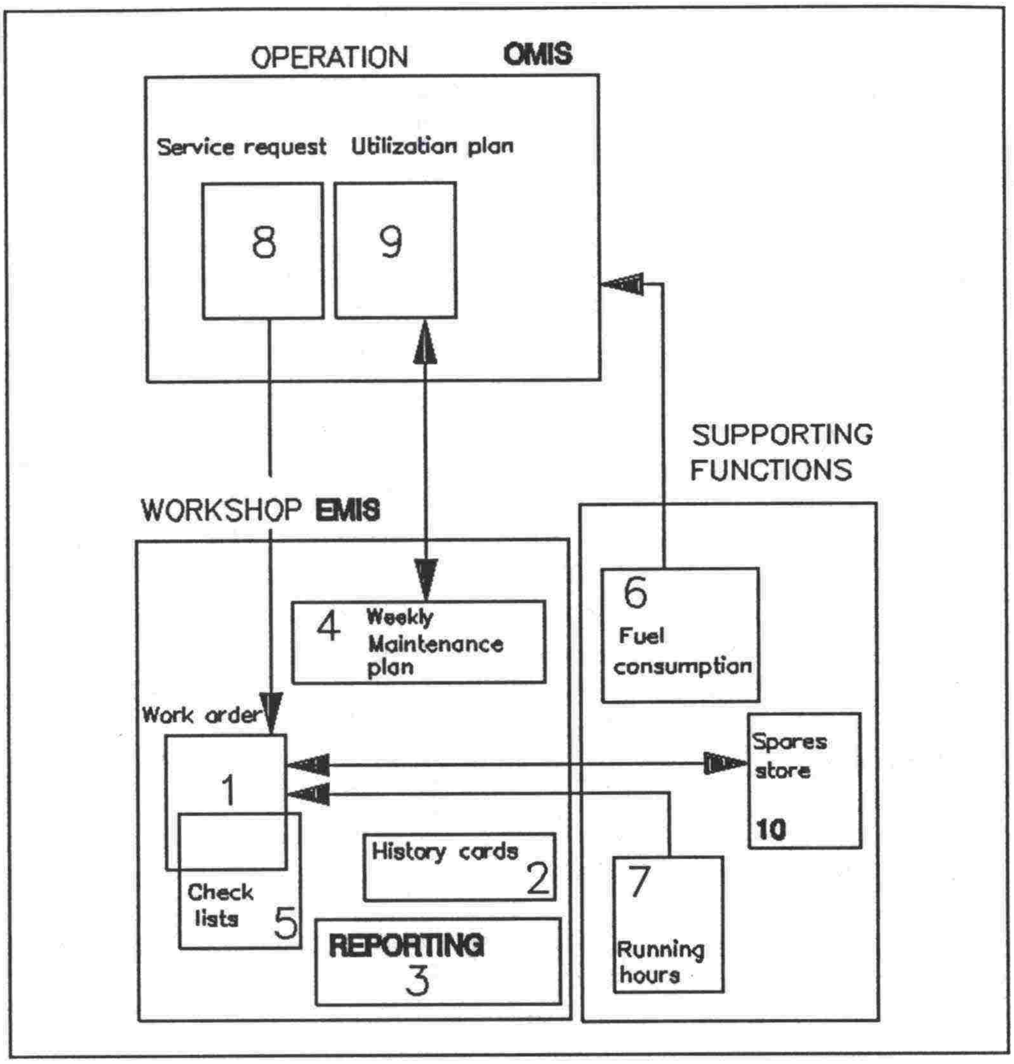
3.3.2 The Forms

The new information system (Picture 6) is based on the new work order {1}.

The data from the work orders is transferred to the history cards {2} from which it is possible to make summaries and reports depending on the needs {3} (Appendix 3 and Appendix 10). The work order can be opened either for an internal workshop maintenance work or for servicing equipment after a request from the Operation.

For internal works there is no need to fill in a service request. The service request has been adopted only for the sake of information exchange between the Operation and the Maintenance {8}.

There are several check lists {5} to ease the practical maintenance work. Some check lists are even filed, which is unnecessary and space consuming. The information value of the lists is low because they usually have all tasks check marked anyway.



Picture 6 Chart of the New Information System

The possible defects found during the inspection should be reported to the foreman or filled into the work order as remarks. The filing of check lists has probably been an excuse for not properly filling the actual work orders.

There is still a vast number of forms for getting items from the store. The forms could be replaced by a system consisting of work orders and a log book. The log book would be kept in the store and the numbers of the work orders and the items given out would be filled in it. The log book would also contain information about who signed out the items. The work order will be signed by the store keeper.

The authority of using the store is on a high level. Probably a fear of misusages of the store has led to many forms. This mistrust turns against itself when the spares can't be taken out if the management is not present. On the other hand, the mere number of forms doesn't discontinue forms for non-existing works. A simple and clear system is easy to control, using a log book it is possible to check if the signatures and quantities match those in the work orders.

The running hours/kilometers are collected weekly on separate forms {7}. The consumption of fuel are reported on a form used by the fuel delivery station {6}. At this point of the planning it should be decided which system should keep track of the fuel consumption the EMIS or the OMIS. It would seem natural for the Operation to follow the total running costs and in that case also the fuel consumption.

For the information exchange between the Operation and the workshop, the Equipment service request is used {8} (Appendix 4). The idea of the form, when it's properly filled, is to reveal the weaknesses in the information exchange. This means, for instance, situations where the maintenance work is completed but the machine has not been collected by the Operation. When the co-operation starts working better the the form can be abolished and the work orders will be opened without extra forms. The Operation can use a table for the equipment follow-up, which can contain the estimated finishing times of individual maintenance works.

The workshop planning group has a Weekly Maintenance Schedule {4} and a Daily Equipment Allocation Form {9}, which is aimed towards enhancing of the information flow between the Operation and the workshop.

- The Weekly Maintenance Schedules {4} (Appendix 5) are to be filled based on the scheduled service. The form should be presented in the first planning meeting of the week. In the meeting the best times to maintain the equipment should be agreed upon. The form states the type of maintenance and the estimated time for the work to be accomplished.

- The Daily Equipment Allocation form {9} (Appendix 6) is to be presented in every planning meeting. The workshop should fill in the column of the available equipment. The form is actually a tool for planning the usage of the resources for the next three shifts. The planning will show if there is a shortage of equipment. When the co-operation is working the Operation should be able to request that the workshop put extra effort into the maintenance of key equipment.

3.3.3 The Statistics

The follow-up of the work orders was prepared with Lotus 123, which is a PC based spread sheet. The first statistics were for the utilization of the manpower. The choice was natural because the World Bank was also studying the man-power and the possibility of introducing a incentive program in the port.

To be able to start using incentives there has to be a reliable follow-up of the working time and a study of the need for capacity. The reasons cited for the project were observations of low working morale in the port. The lack of morale has been seen to be caused by the low salaries, which doesn't guarantee a sufficient real income for the majority of the workers.

The work orders were collected every monday and the working hours of the previous week were fed into the spread sheet. These hours included also the hours of the unfinished works.

The total man hours were collected from a daily work hour form which was sent to the Accounting department. The form states the total number of personnel and their working hours per working class. The spread sheet will calculate the daily and weekly utilizations. A data base was created and an application was implemented for work order and equipment follow-up.

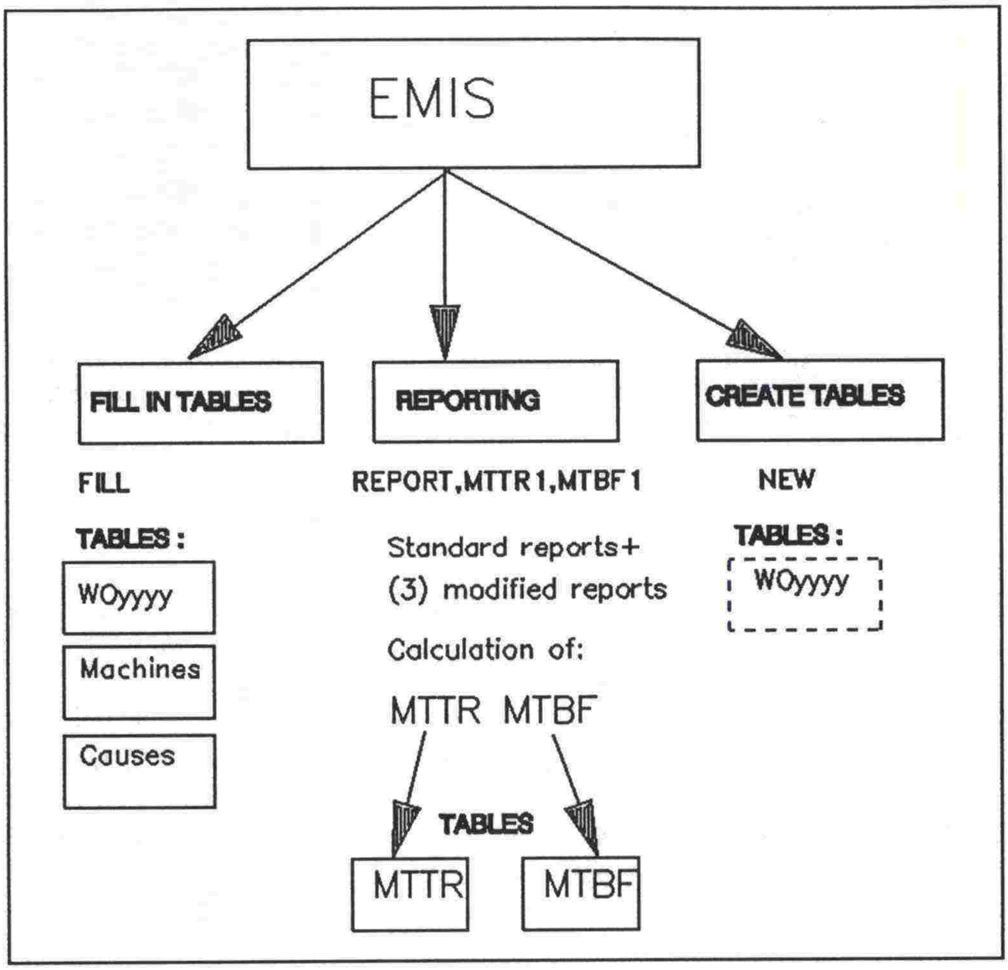
3.4 EMIS the Data Base and the Application

The workshop was using (in May -91) two OLIVETTI PC-XT computers, with 20 MB hard disks. The port project also has a BORLAND PARADOX ver 3.01 data base at it's disposal. The PARADOX program demands quite little of the computer. Only less than 3 MB of hard disk capacity, 640 kB of RAM and MS-DOS ver. 3.xx. Into this environment an application was implemented for (Picture 7) :

- Updating the equipment and maintenance history data bases.

- Updating the causes or the service groups data base, which is used for finding out the characteristic failures.

- Updating and creating work order data bases, which are the basis for all follow-up calculations.



Picture 7 The Structure of EMIS

- Printing follow-up reports like the work orders for an equipment, the mean time between failures and so on. The default in all reports is the A4 paper, which can easily be changed with the basic commands of the PARADOX program.

The PC based program implementation has several advantages like a large number of users, a big amount of applications and the proportionally low price of the computers. The large number of users ensures the continuing development. The big amount of applications can be a disadvantage if the chosen program is not in a wider use. This is a minimal risk with the Borland products. Borland Ltd is one of the most popular developer of language compilers and data bases. The low price can be described by the fact that for the price of one mini computer one can get, depending on the configuration, from five to ten PC computers.

The implemented application uses the existing computer capacity, which doesn't inhibit the application in any way. The application was kept simple on purpose and it was built using the basic PARADOX commands. This will make it easy to administrate and change even with minimum training or studies of the manuals.

The choice of a universal development tool makes it easier to buy outside knowledge for further development. The data base program includes the following data types, which the later presented data bases consist of :

DATA TYPE	EXPLANATION
D	Date of format dd.mm.yy
S	An integral number (Short number)
N	Floating point number
Ax	String (x=the number of characters)
*	Is added to the type to describe an indexed field, which means that the field can only have unique values.

3.4.1 The Data Bases Structure

WORK ORDERS. The basic data is kept in the work order data bases. The data bases are automatically named WOyyyy, where yyyy stands for the year. When a new data base or table, as it is called in the PARADOX program manuals, is created the user is prompted for the year. The application will use a data base named MODELWO as a model when it's creating new data bases. Any changes made to the MODELWO data base or its reports will be transferred to all data bases which are created after that. The MODELWO data base is actually copied with its reports during the creation of a new work order table. The WOyyyy consists of the following fields.

Field Name	Field Type
WS-REG-NO	S
YEAR	S
MONTH	S
NUMBER	S
DATEIN	D
DATEOUT	D
WS-HOURS	N
MAN-HOURS	N
MAN-COST	N
PART-COST	N
LUBRICANT-COST	N
LTR-LUBRICANT	S
PRE-MAINT	A1
CAUSE	S
H-METER	N

The structure of the data base is based on the new work order form. Most of the data could however be found on the old form as well. The YEAR/MONTH/NUMBER fields refer to the indentifier fields on the top of the form. The type of equipment (FEL/SSG etc.) is not fed to the system because it is uniquely described by the registration number (WS-REG-NO). The equipment has been grouped to classes 000-500 depending on their type (Appendix 7).

The fields for the DATEIN and DATEOUT are found on the top of the form. The DATEIN is used when the mean time between failures is calculated (MTBF).

The fields WS-HOURS and MAN-HOURS refer to Workshop hours (the worked hours between the starting date and finishing date) and the used Man hours. The mean time to repair (MTTR) calculation is based on these hours.

The costs are fed into the *-COST fields. The cost types are divided into work-, spare- and lubricating costs. A space for the liters of lubricating oil has been reserved. If there will be a fixed price for the man hours the calculation of work costs can be automated.

The other fields include data about the meter reading at the maintenance moment (H-METER), the cause or type of maintenance (CAUSE) and a tag if the maintenance has been a scheduled one (PRE-MAINT) are fed. The scheduled maintenances will not be included when calculating the MTTR and MTBF figures.

MACHINES . All equipment types are fed into the MACHINE table. The table can be used as a reference (lookup) table when data from the work orders is fed to the WOyyyy table. The description of the MACHINE data base is:

Field Name	Field Type
WS-REG-NO	S*
THA-ASSET	A20
EQ-TYPE	A4
EQ-DESCRIPTION	A20
MANUFACTURER	A15
MODEL	A15
MANUFACTURER-NO	A30
ENGINE	A30
ENGINE-NO	A30
CAPACITY	N
PROCURED	D
PRICE-USD	N
REMARKS	A40

The data base has been indexed by the registration number of the equipment (WS-REG-NO), because there can't be two pieces of equipment by the same number. The other fields are common with the old History card (Appendix 8). The THA-ASSET is a inventor code given by the Harbours Authority. The EQ-TYPE is the same as the group code in the work numbers (FEL,SSG etc.) and EQ-DESCRIPTION is the literal explanation of the code. The other specifications of the equipment are fed into the fields MANUFACTURER, MODEL , MANUFACTURER-NO (serial number). The information of the power source is fed to ENGINE and ENGINE-NO fields. The field CAPACITY states the nominal capacity of the equipment. The nominal handling capacity for the VALMET FLT 4212 is for instance 40 (tons).

The field ProCURED is for the date of purchase and the PRICE-USD for the price in US-dollars. Wheter the prices will be followed in USD or in Shillings is of course up to the local administration. However while the equipment is procured abroad and usually paid for in USD it would be logical to follow the investment in dollars. If the same practice is followed for the spares, the purchasing price of the spares won't get distorted because of the devaluation of the local exchange. To list other observations there is a REMARKS field.

CAUSES/MAINTENANCE TYPES. The old work order (Appendix 1) has 93 different codes for the follow-up of the causes for break-downs and the condition of the spares. The basic idea was apparently to find out the typical failures. The codes are however not grouped in a logical way, the list seems rather like it had appended whenever the need has arose.

The CAUSES data base is grouped in hierarchies. The causes can be appended by means of a more detailed division after the main problem area, like the most costly or most time consuming, have been found. The data base is defined as :

Field Name	Field Type
CODE	S
NAME	A40

And the preliminar classes are defined as:

- **CAUSES-/MAINTENANCE TYPES:**

100 PREVENTIVE MAINT.

200 MOTOR

300 TRANSMISSION

400 ELECTRICAL

500 TYRES

600 ACCESSORIES

900 OTHER

The classification is hierarchial consisting of a three number code. Under each class there can be sub-classes. The classification is planned to be used also for the scheduled maintenances, which could mean different things for different equipment. To be able to do this the preventive maintenance system should be more exactly defined and the common features should be found. The subdivision could be as follows :

110 BASIC SERVICE 1

120 BASIC SERVICE 2

130 ANNUAL SERVICE

190 SPECIAL SERVICE

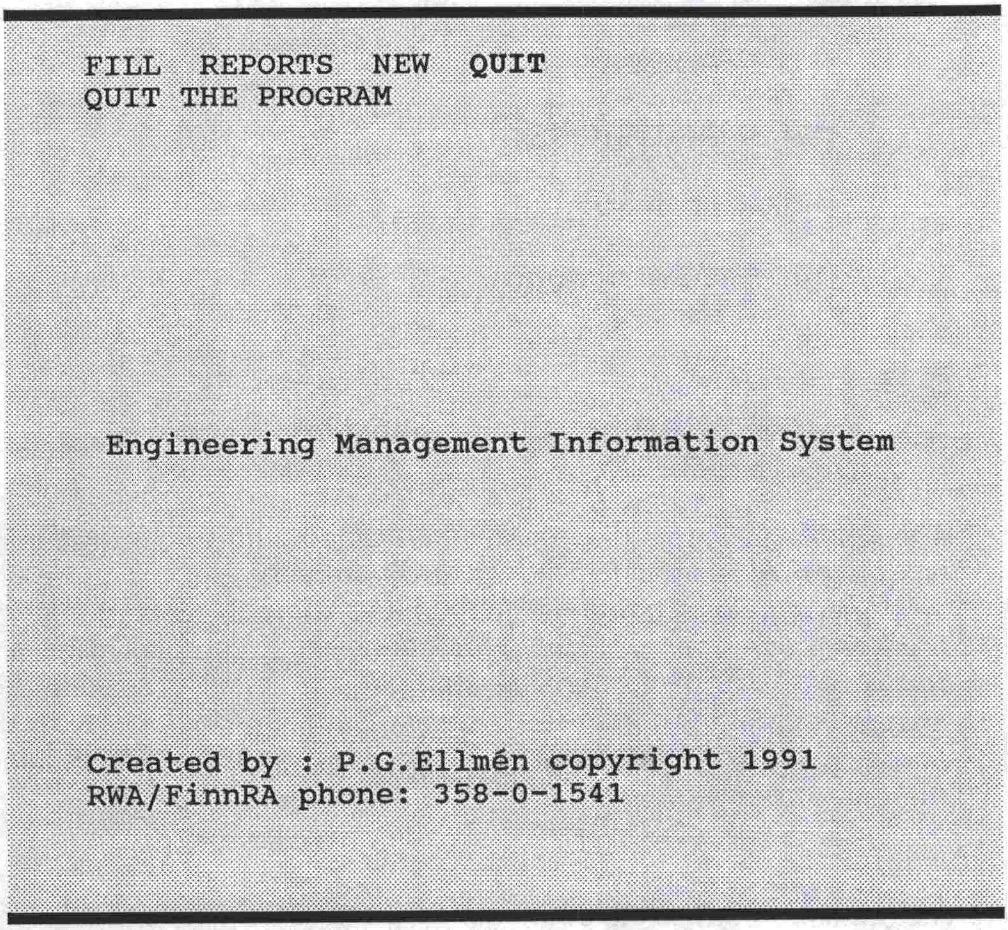
3.4.2 The Application Structure

The entire application has been constructed with the programming language PAL of the PARADOX program. PAL can be compared with the high level computer languages. The difference is that the program code doesn't need to be compiled. It can be written and run in the ASCII format (a standardized way of coding the characters in a PC computer). The PAL language includes both the normal control constructions and the commands for manipulating the data bases.

The application consists of a main program (EMIS.SC) and of seven sub programs (FILL.SC, REPORT.SC, OT-REP.SC, WO-REP.SC, MTR1.SC, MTBF1.SC, NEW.SC). The program is run with the DOS command **PARADOX EMIS.** For the EMIS program a sub directory should be founded. A good place to put it would be under the PARADOX program directory where all EMIS programs and data bases should be copied to. Before starting the program this newly founded directory should be made the working directory with the configuration program of PARADOX (CUSTOM.SC).

The EMIS program will run in the directory where it has been started. The name of the directory can be chosen freely. The name of the hard disk will however be expected to be C:.

The program will function interactively asking the user to choose the target work order tables (WOyyyy) and the types of reports for print outs. The main menu of the EMIS program is presented in the following window (EMIS.SC):



EMIS Main menu

The main menu selections enable the user to FILL the tables, print out REPORTS, create NEW work order tables and QUIT the program.

Selecting Fill (FILL.SC) will ask the user to select one from a list of all existing tables in the current directory. The user can either select the data base or return to the main menu by pressing the ESC key. In case of a selection the application goes into the editing mode using the default input form, like the modified one shown for a WOyyyy , and creates a new empty record for the user to fill.

The Input form is filled using the basic PARADOX commands. When a form is being filled the user can also update old information. The keys PAGE UP and PAGE DOWN move the user between the records in the table. While filling the work order data base the user can get a value from an lookup table by pressing F1. In the WS-REG-NO field, a number is taken from the MACHINES table and in the causes field from the CAUSES table.

```
CHOOSE THE TABLE TO FILL IN (Esc to RETURN)
Wo1990 Machines Causes Mttr Mtbf Modelwo  Wo1991


Press F2,update or ESC, return without updating
use arrows(move) in some fields get HELP with F1

 WORK ORDER FILLIN FORM       Wo1990     #     27
 ======================
               yy     mm     nnn
        NUMBER:__  /  __  /  ___

        WS-REG-NO:    DATE IN : DATE OUT :

          ____        __ __ __  __ __ __

     HOUR METER READING :   WORKSHOP HOURS :

        ______                    ______


    CODE FOR THE GROUP MAN HOURS        : ___
    WHICH WAS MAINTAINED :
          ___      COST of MAN-H  : _____
                   COST of PARTS  : _____
 WAS MAINTENANCE COST of LUBR.   : _____
 PREVENTIVE (Y/N) : AMOUNT of LUBR.:_   (ltr)
           _
```

Filling the work order table

For reporting, REPORTS (REPORTS.SC) is selected, after which either TABLES (WO-REP.SC) or OTHERS (OT-REP.SC) is selected. The selection of TABLES gives the users again a list of all tables in the directory. After one of the four reporting models is chosen, the user has to specify if the printout will go to the printer or the screen.

The reporting module has some weaknesses. The module expects a table to have four report models. This means that all tables must to have at least four reports and if there are more than four the others can't be used. The reports of the Work order and Machine tables are (Appendix 10) :

```
TABLES  OTHER  RETURN
REPORT OF EXISTING TABLES
------------------------------------
CHOOSE THE TABLE AND PRESS ENTER
Wo1990 Machines Causes Mttr Mtbf Modelwo  Wo1991
------------------------------------
R  1  2  3
STANDARD REPORT
----------------------------------
SCREEN  PRINTER
SCREEN
-----------------------------------
Now viewing Page 1 of Page Width 1
Press any key to continue...

                   WORK ORDER
28.04.91        Standard report   Page   1

 WS-                    WS  MAN LUB.        H-
REG-NO WORK OR. DATEIN  -H  -H  LTR  CAUSE METER
----------------------------------------------------
207  90/11/ 46 11.12.90  15  22  5      500
 21  90/11/ 77 22.11.90  10  23         100  5237
305  90/11/ 86 16.11.90  16  60         400
301  90/11/ 87 20.11.90  24 110         200  1053
 14  90/11/ 96 22.11.90   8  14     Y   110 25002
 17  90/11/101 23.11.90   6   6         400
 25  90/11/103 23.11.90   6  11 30  Y   190  4389
 28  90/11/104 22.11.90   6   5         900  2896
 16  90/11/105 23.11.90   1   1         400
181  90/11/109 24.11.90   3   3         500
 19  90/11/110 24.11.90   1   1         400
```

Reporting example (EMIS)

WORK ORDER TABLE (WOyyyy.DB)

R Standard Report. Work orders grouped by the month and sorted by the number.

1 Maintenance per Machine. Work orders grouped by the machines and sorted by month and number.

2 Maintenance pro Maintenance type. Work orders grouped by the cause/maintenance type and sorted by month and number.

3 Cost of Maintenance pro Machine. The cumulative maintenance costs pro equipment group.

MACHINES TABLE (MACHINES.DB)

R Standard Report. The equipment grouped by the type and sorted by the number (demands a landscape A4 with the condensed text type).

1 Machines per Manufacturers. The equipment grouped by the manufacturers and sorted by the numbers.

2 Dates of Procurement. The equipment grouped by their types and sorted in descending order by the purchasing date.

3 Basic information. The key information of the equipment. This is in practice a simplified standard report fitted to and portrait A4 paper.

The information that is in the Appendix reports contain both actual and fictional data. The idea of this is only to show which form the data is presented in. Defining a fifth report won't automatically make it appear in the menus. The reporting module (REPORT.SC) has to be revised and all the other tables should also be added with a fifth report. The reporting module doesn't show the actual description texts of the reports.

The clumsiness of the report choosing is due to the lack of programming tools. With PARADOX functions, it isn't possible to check the number of defined reports in a table. All tables must simultaneously have four defined reports, even if they are copies of the same report, otherwise a program error will occur.

The menu choice OTHERS gives two options. The user can choose a calculation of the MTTR (Mean Time To Repair) or the MTBF (Mean Time Between Failure) for a certain equipment during a certain year. The values won't be calculated for those work orders which are caused by scheduled maintenance i.e. records which have the letter Y(es) in the PRE-MAINT field.

The MTTR module (MTTR1.SC) calculates two values for the piece of equipment selected by the user. One value is the work shop hours divided by the number of break-down work orders and the other is the man-hours divided by the same number. These values are saved in a MTTR table which the user can add the values of several pieces of equipment and print out a report through the REPORTS selection. If the MTTR table doesn't exist the application will create it automatically. If the table exists the application will ask the user if it should be cleared of the previous data.

```
TABLES  OTHER  RETURN
CALCULATED REPORTS
________________________________________

MTTR  MTBF  RETURN
MEAN TIME TO REPAIR
________________________________________

CHOOSE THE TABLE TO CALCULATE FROM (Esc to RE-
TURN)
Wo1990  Wo1991

________________________________________

 GIVE THE NUMBER OF THE MACHINE (0 to return)
:303

________________________________________

 MTTR TABLE EXISTS SHOULD IT BE EMPTIED (Y/n) ?y

________________________________________

MTTR  MTBF  RETURN
RETURN TO MAIN MENU
```

Calculating the MTTR (EMIS)

The MTBF module (MTBF1.SC) calculates the difference between the DATEIN values of the work orders of selected equipment. The MTBF value will be a number of dates whereas the MTTR calculates hours. The MTBF value is a gross value including the eventual holidays etc. The values will be saved like the MTTR values in a MTBF table, the same things applies to both the MTBF and the MTTR tables.

To create a new work order table, the choice NEW (NEW.SC) should be selected. The user is then prompted for the year (yyyy) and the application will create a table named WOyyyy, if it doesn't already exist. The name is fixed because the MTTR and MTBF modules expect the work order tables to have certain names. The new table will inherit the report models and forms of the MODELWO table. There is no selection for deleting tables, this should be done with the PARADOX commands or with the operating system commands. This has been found to be a necessary precaution, especially with new applications and users.

```
FILL  REPORTS  NEW  QUIT
CREATE NEW WORK ORDER TABLE

________________________________________________
    MAKING A NEW WORK ORDER TABLE GIVE THE YEAR
      FOR THE TABLE NAME (format yyyy) :1991

THE TABLE WO1991 ALREDY EXISTS RETURNING..

________________________________________________
      MAKING A NEW WORK ORDER TABLE GIVE THE
YEAR
         FOR THE TABLE NAME (format yyyy) :1993

            CREATING THE TABLE WO1993

________________________________________________
FILL  REPORTS  NEW  QUIT
EXIT THE PROGRAM
```

Creating a new work order table

3.4.3 Comments about the Application

The EMIS application should be seen as the first step in the development of a complete system. It is of utmost importance to get the system into trial use and to create a team to improve and further develop the application. The pros of the application are :

+ It makes it easy to combine the loose information of the work order forms into usable reports for the management.

+ There will be a reduction of manual work and errors in summarizing the data. Feeding the data into the system makes the filing of work orders easier. Work orders can be sorted only by the work number without grouping them by the equipment. The simplification of the filing system will increase the probability of finding the work order later on if the need for specified data arises.

+ The ease of use. The application demands very little knowledge from a user who only feeds in data or prints out reports.

The major cons of the application are :

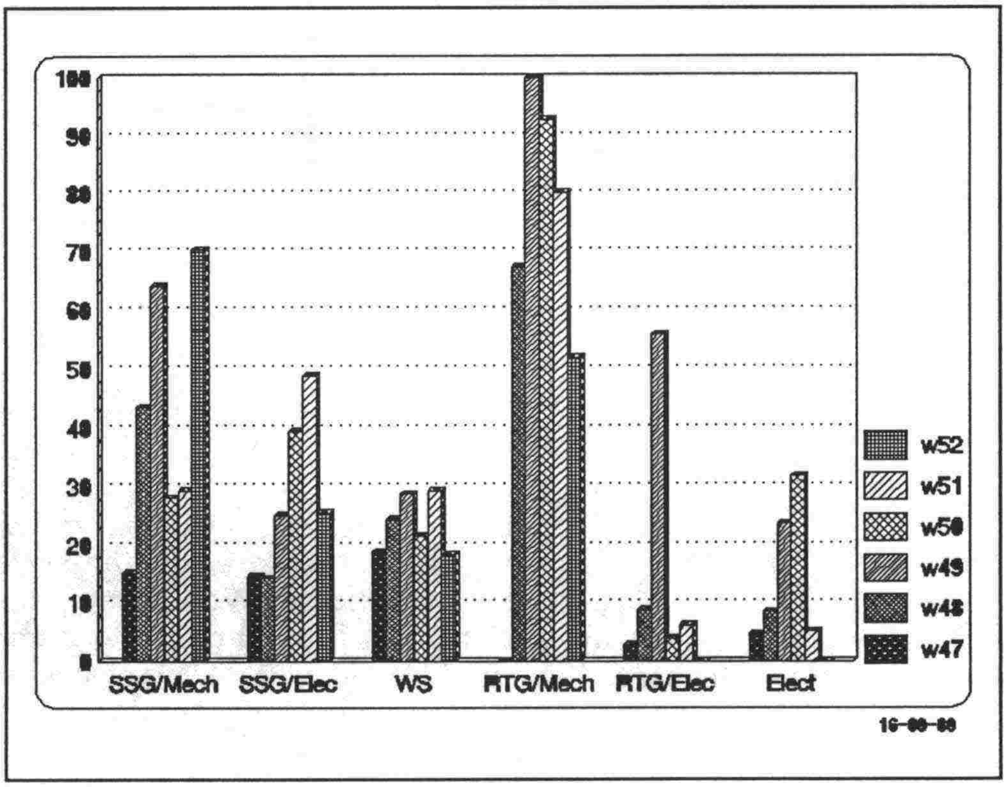
- The small scale. A complete system can never be created at once. The system work will be a co-operation between the user and the developer on the way towards an ideal system. The current application is lacking the follow-up modules for the personnel and the stores.

- Some program solutions could be improved. The values of the MTTR/MTBF should be able to be calculated for a group of equipment also. The interactivity could be improved in the reporting modules.

4 ACTIVITY ANALYSIS

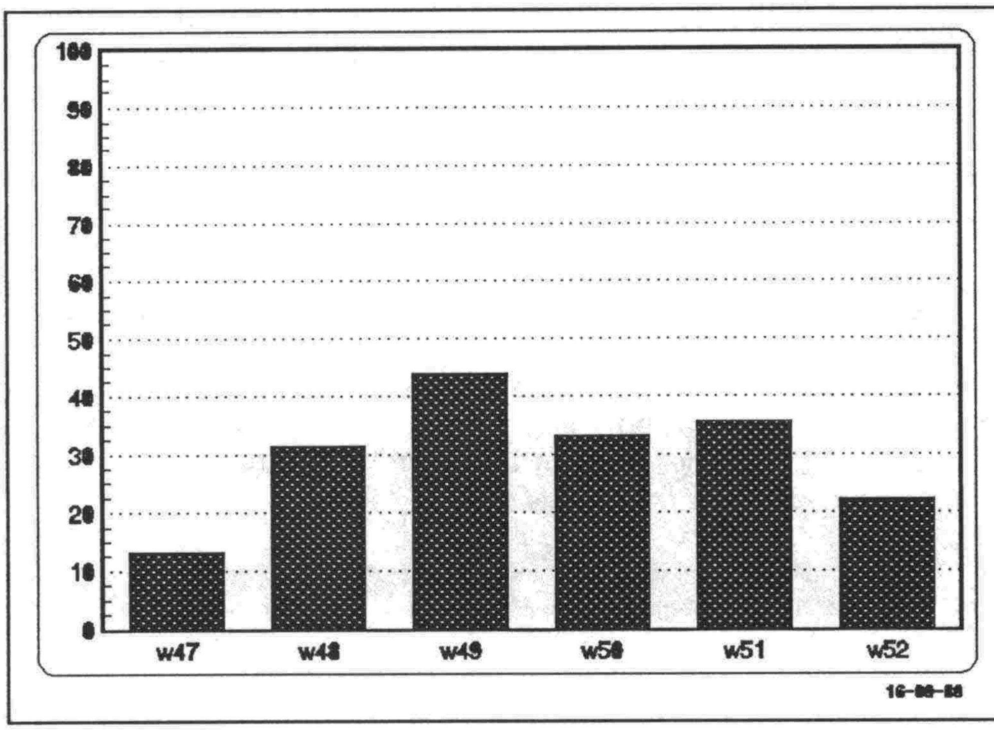
4.1 Information analysis

The new work order was taken into pilot use in October 1990. At first the utilization of manpower was followed (Picture 8). The figures from this computation did not look good with a total utilization being around 30 %.



Picture 8 Utilization of Workshop Manpower

According to a World Bank study the condition of the information system in 1990 was so poor, that the excess capacity could not be defined. The study however estimated that the workshop was overstaffed and could do without half of its personnel. The remaining half, which had vital working roles, could then be paid a decent salary. A better salary is believed to motivate the personnel to better performances and to develop their professional skills. In the current state of the analysis an estimate of a utilization between 30 and 50 % seems optimistic (Picture 9).



Picture 9 Workshop Total Utilization

4.1.1 The Reliability

The received data should be analyzed with reservations. The old system produced a lot of paper and the people in the workshop had been accustomed to the practise of the management not reading the actual information in the papers as long as the papers seemed to be tidy. Problems are also created by the low level of education, it can't be taken for granted that all of the employees are able to both read and write.

The basic concept of increasing the reliability is to simplify the system. This makes it easier for a foreman or the management to spot errors. At first, almost all work orders had to be handed back because they were improperly filled. The working hours for example exceeded the time of the operation and the man hours exceeded the available daily hours.

It was difficult to make the personnel understand the importance of opening the work order for all works. Some internal work was still done without a work order. This causes the utilization to appear somewhat lower than it actually is. The intentions of the foremen can be questioned i.e. some of the data might have been written to give an idealized picture of the actual situation. It seems that there is a habit of giving the management figures they want to see instead of figures which tell the truth. The utilization of one maintenance group during week 48 was 140 %.

The work orders have been filled after the work has been finished, because the old form only included the total time spent on maintenance. Using the new work order requires in principle a daily filling. Paper work will be more equally divided in this way. One has to be systematic when filling out the forms. If some of the paper work is left undone, it might be difficult to remember the worked hours later.

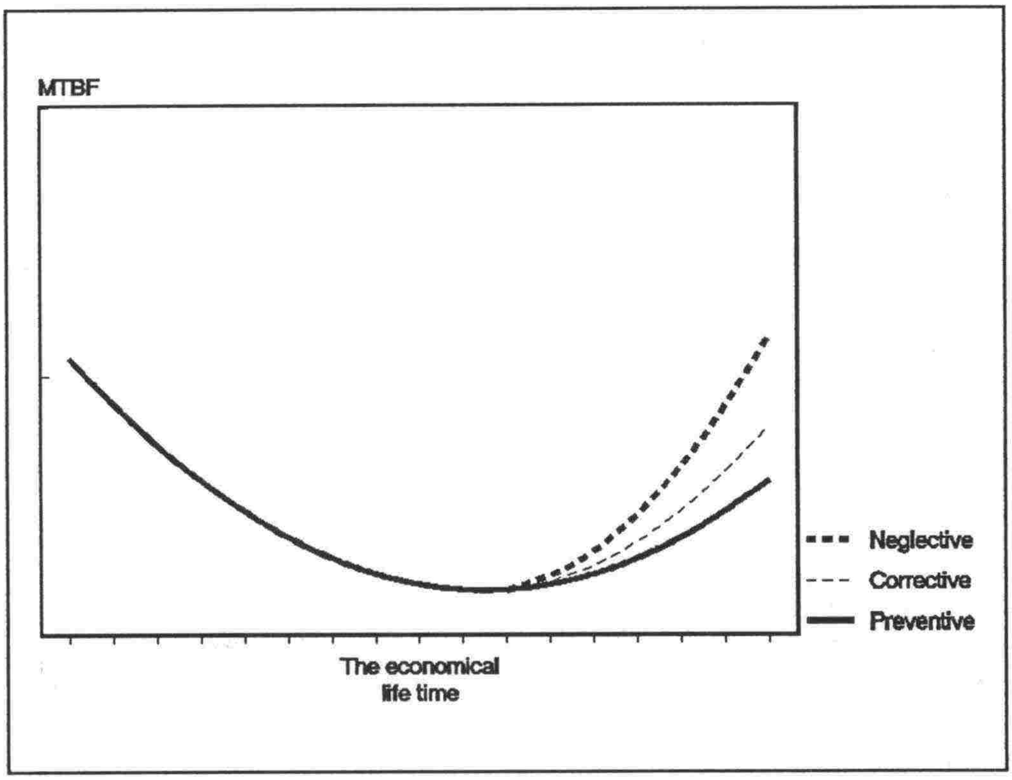
4.1.2 Sufficiency

The presented application is sufficient for collecting basic information. The application enables the management to follow the condition of the equipment with the MTBF and the MTTR values. At this point the scheduled maintenance is left in the background and the follow-up concentrates on finding causes for break-downs and typical equipment failures.

The application makes it possible to spot the changes in the follow-up values for a certain equipment group. A lot of failures in a certain group of equipment may stem from a background cause. An increase in the number of the trailer tire flats might point to the bad condition of the pier paving. The application enables, with the basic reports, a follow-up of the number of maintenance hours used on a specific piece of equipment.

The reporting should be developed so that it would be possible to find out the current point on the economic life span graph. This would mean a continuous follow-up and filing of the MTBF values. It would be best to start the follow-up with the key equipment. The important aspect is the continuosity of the follow-up. Proper analysis can be done only if the data has been collected over a longer period of time. There is still time to start the follow-up during the current project. This would give time to gather data over a period of two years.

It has been estimated that in developing countries the graph of the MTBF values would rise more rapidly compared to the industrialized countries (Picture 10). This is said to be caused, among other things, by the maintenance attitudes and rougher use of the equipment.



Picture 10 The Density of Failures /3/

The values of MTBF will rise rapidly if maintenance is neglected and less rapidly if only corrective maintenance is done. To use equipment until it breaks down will cause damage to other parts as well (metal chips in the oil etc.). Preventive maintenance will make the economic lifetime of the equipment longer, which is important when the making new investments is difficult.

4.2 Problem Areas

In a World Bank study of the maintenance situation in developing countries in general /9/, nine major problem areas were listed.

1. Equipment follow-up is poor. Maintenance managements aren't collecting information or suitable follow-up systems are lacking.

2. The co-operation between Operation and Maintenance is poor. The current information channels are either neglected or the management is not able to co-operate.

3. Spares and materials are not available because of poor budgeting and insufficient storage follow-up.

4. There is a motley fleet of equipment, which causes maintenance and operation problems.

5. Preventive maintenance is inadequate which leads to numerous break-downs and to the early scrapping of equipment. Problem areas among other things include the low educational level of both maintenance and operational personnel.

6. The workshop facilities and tools are unsatisfactory and good engineering practice is not followed.

7. The harbour buildings, piers and work surfaces are in poor condition. It endangers the handling operations and causes damage to the equipment. The cause is again mismanagement.

8. The availability of equipment is low because preventive maintenance is poorly planned and carried out.

9. The type and number of equipment is not sufficient to satisfy the operational needs.

In regards to Dar Es Salaam the first four statements in the list apply and the next two are also true in some cases. The general apperance of the port gives the impresson that there has been poor maintenance plan for the driveways and buildings. Without a boost in general maintenance, the improving of equipment maintenance will be in vain if poor driveway conditions will cause flats and broken rims.

The worst problem of the follow-up is once again the lack of a general system. Papers are filled in different sections of the ports but the collected data is never summarized. The whole organization could use a touch of constructive self criticism to find out if some of the paper work has become an end it itself. If that is the case then the paper work should be revised.

The heavy mid management and the lack of general strategies is a problem. Currently the mid management of the workshop is busy solving the problems of the practical maintenance work, which causes a lack of long range planning. The tasks of the different organization levels should be defined and possible overlapping should be removed.

The management should be able to rely on the ability of the technicians and to leave the practical work to them. The technicians should be able to do this because several technical courses have been held during the course of the development project. In addition, there is a organization of counter parts (Technical Assistants), with whom technical issues can be discussed and solved.

The work shop is in a situation where the criticism is moving easily downwards through the organization. Constructive discussions are not held over the problems caused by the current state of affairs. There is no development of the existing system and no follow-up. The same errors will occur again because they are never documented.

Co-operation between the managements of the Maintenance and the Operation is not working. The representatives of neither departments have enough vision to see the importance in co-operation.

The lack of general guide lines causes scattered follow-up. The Planning group would be the right place for filing the maintenance histories and for making reports. Still the maintenance history is presently scattered and kept both by the Planning group clerks and by the technicians.

The running numbers for work orders are taken from different sources. To find a work order one has to know the type of the equipment and the type of problem (electrical or mechanical).

The paper work is unbelievably sloppy with few exceptions. The filing system is unclear and the work order lists are blurry. The knowledge that every piece of information is hard to obtain lessens the enthusiasm for follow-up.

The lack of motivation can be seen in the employees who carry out the paper work. When no one takes any interest in the work it will be done with a minimum of effort. There has been no development of the paper work because it has been easy to explain that there is a lack of an overall system or that nothing is allowed to be developed without the permission of the Harbours Authority.

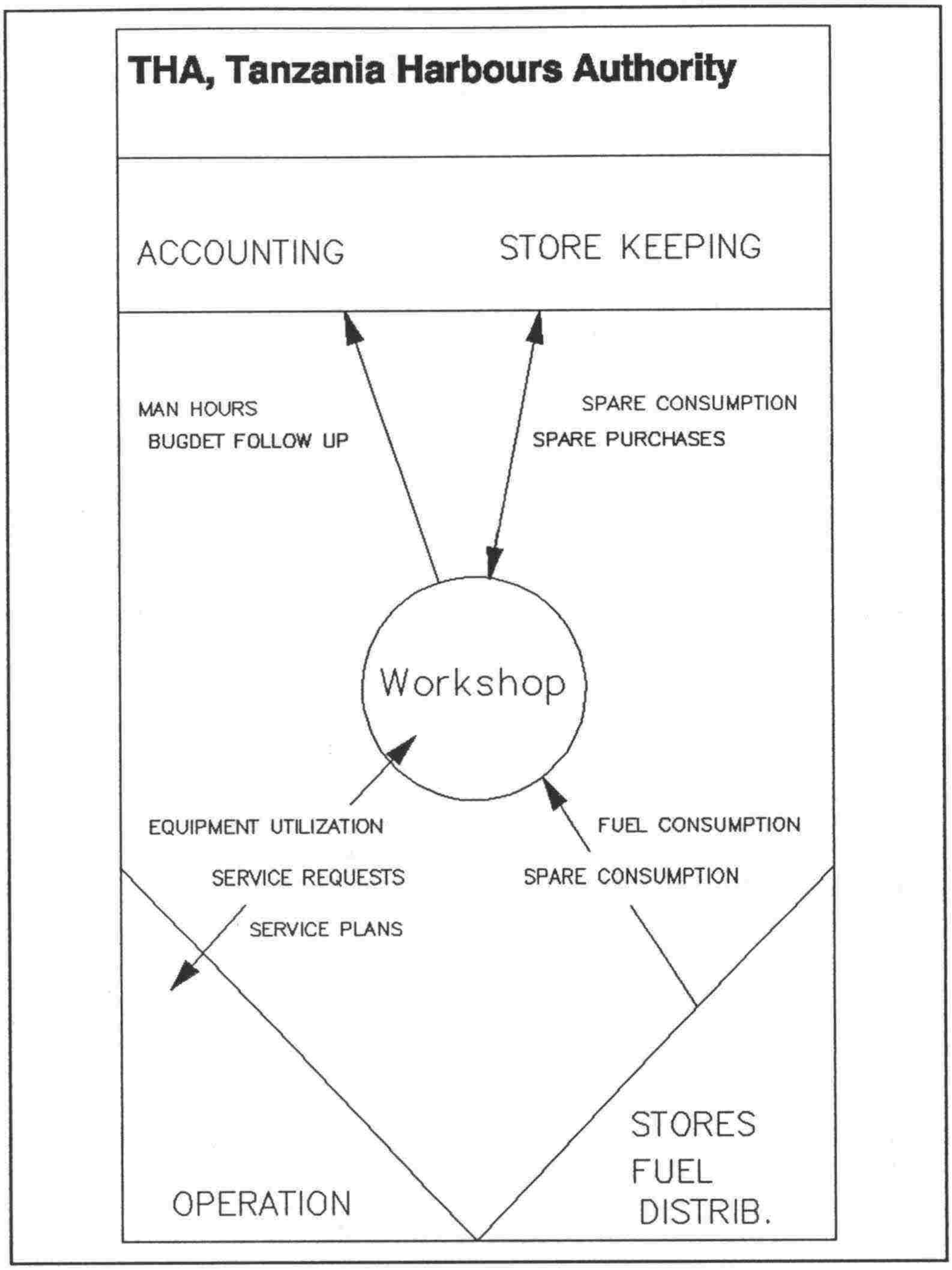
The resistance to change is great. It seems that the main questions are how to make the present management:

- Admit the lack of the current system.
- Accept the necessity for change.
- Become interested in developing the system in co-operation with the Technical Assistants.

4.3 The Interconnections Between Departments

In the port organization there are several departments that need information from the workshop, such as, the Operation, the Accounting office, the Store keeping and the port management (Picture 11). The forms exist, but while the information handling capacity of the departments have deteriorated, the information is no longer filed or even asked for.

When developing the system the starting point must be information which is vital to the workshop. The needs of the adjacent departments should be taken into account, if possible, when the type and format of the information is defined. The objective is to file the data in a format, which is detailed enough to enable the making of appropriate reports. Usually, due to a lack of communication, separate departments will gather information and put it into summaries containing the same basic data only in different formats.



Picture 11 The Port Information Exchange

From the workshop point of view the most important day to day connection is the one with the Operation. The Operation should be interested in the equipment maintenance costs and the workshop should on the other hand be interested in the distribution of the port work load and its trying to plan activities according to peak situations.

5 THE FURTHER DEVELOPMENT OF EMIS

The goals for the development work should be pondered critically. The mere collecting of data is not a sufficient goal. The collected information should serve the decision making, development and the profitability targets.

The major problem is the unclear structure of the current system. The simplification of the system will make it clearer and easier to control. It will also make the collection and filing of data more systematic.

The target of the near future should be to collect basic data for the later analysis. The analysis should improve the targeting of the preventive maintenance and make the lifetime of the equipment longer.

Without the support of the management the development work is impossible and when the equipment becomes older it will be harder and harder for the workshop to maintain the availability of the equipment. The workshop will start going from one crisis to another while no information or analysis exists for preventing them.

To implement the system some basic physical frames should be created. This means mainly the rationalization of the paper work. Its importance should also be emphasized. The following steps should be taken :

- The management must start to support the follow-up. Currently, inorder to abolish the sloppiness of the system, it will demand a greater involvement, i.e. checking the paper work and demanding the reports. The importance of the work order as the basic document should be emphasized and the forms should be handled accordingly.

- A routine for accepting work should be defined and the same goes for the route of the work order. The defining of the route includes also defining the responsibilities, i.e. who should know where the work orders can be found. Specific work places or desks for the temporary filing of the work orders are to be decided.

- Every work place handling the work orders should have one specific place for the incoming and for the outgoing forms. This way, it is simple to collect the forms when it's time to make a monthly summary.

- One room should be reserved as the files room, where the compleated work orders are filed. The logical way is to file the forms by the work number or grouped by the equipment.

- A work order should be opened for all works. If the workshop has a mechanic on duty there should be a work order for the duty work. In this way the personnel follow-up will be quite accurate.

5.1 Expanding the System

The first step in expanding the system is to include the spare part stores and the personnel management. Some of the data for the utilization of the personnel has already been fed into the application from the work orders. An independent table of the entire personnel should be created in which the daily absences could be fed. Combining the reported man hours and the total available personnel hours gives the utilization of the personnel.

When expanding the system the question of purchasing more computer capacity will arise. If the basic ideas of creating relational data bases (the same data is to be stored only once) is followed, the processing of the data bases will not become too slow even with the current equipment.

When the amount of data increases the space on the hard disk will run out. This can be solved either by purchasing bigger hard disks or more computers. The latter alternative is to be recommended, because it will also add an extra storing unit, which will prevent the feeding of the information from becoming a bottleneck.

The half-way target, in the expansion of the system, would be the purchasing of a computer for all sub units (store, the sections of the workshop, personnel management). The computers would process the basic data and make summaries for the computer in the Planning or in the Managers office, which will then make overall reports and analysis of the workshop for the management. The information exchange could be carried out with data disks.

When the basic system is advanced enough for maintenance planning, it should also be able to send warnings to the storekeeper to check for the availability of spares for the incoming maintenances. The defining of the key spare parts is a goal of the store follow-up. This will reduce the effects of the current waiting time for spares, which can go up to months. The long waiting time is caused by the fact that spares have to be ordered with foreign exchange and the bureaucracy for that is heavy.

5.2 Connecting to Other Systems

Connecting to other port systems would mean the defining of these systems. It's clear that one can't refer to an existing overall system. Hopefully when such a system is planned, the development work which has been done by the Maintenance and the Operation will be included.

The border between the Operation's and the workshop's systems are to be defined. The ways of following the costs should be agreed upon. The main question is how the running costs should be defined. If the overhead costs of the workshop can be included in the cost of the maintenance hour, then the overall maintenance costs can be followed with the EMIS application. When both departments start using the same programming tool for the development some synergy benefits are bound to arise.

The information system study made for the port suggested a distributed system model. In the model the departments would functions as independent information islands, which would report to the central administration according to its needs. Unfortunately, the needs nor the format of the information was defined in any way.

The information system of the port has previously been centralized, which means that any problems with the system has caused trouble in the whole port. In the information island scheme, the problems of one department doesn't affect the internal system work of the others.

The development of an overall information system will probably not be financed by one donor. The work is too big to handle and it would be fatal if the donor would change during the development or the implementation work. Therefore it would be wise to define the overall system according to the build-up principle, though it would be good to include some sort of general guidelines.

The project coordinators should quickly define the general guidelines and strategies of the information system. This way these needs could be adopted during the planning and implementation of the sub-systems. Altering the systems is usually much harder later on.

There have also been some ideas that the computers could solve the existing problems by themselves. This is an unfortunate misunderstanding. Computerization needs good preparation work and a clearly defined way of working. With a well defined system, there will be no unnecessary collection of data, which is usually the case with over enthusiastic system development.

6 CONCLUSIONS

The container terminal workshops differ from customer workshops (such as automobile workshops) in the way that they are a part of the port itself. They are directly or indirectly responsible for the profitability of the port. The follow-up of the equipment is much more crucial, because the workshops customers will always service their equipment in the same place.

The comparisons showed that system development in Finnish workshops is only in its starting stage. The need for a system exists, but no one is keen on paying for the development. Different maintenance practices and types of equipment make it difficult to directly apply one uniform system to other places or situations.

In this research a typical port in a developing country was studied, Dar Es Salaam, Tanzania. The main hurdles for development are the lack of motivation, managemental skills and will for change. The current information system in the port doesn't function and it can be said that any attempt at development can only be for the better.

The main follow-up variables were defined and collected into a work order form. To file and report the data, an application was created with PARADOX, a PC based data base program.

The reflections of this study give a picture of the current problems in the workshop. The created application can be used as a tool in the follow-up. The application is now ready to be used with real data and it will be a part of an overall workshop management system. The application includes the follow-up of the actual work and its costs. A separate study should be made to connect the personnel management and the spare part follow-up. The modularity of the application makes it possible to implement new features.

7 SOURCES

/1/	Branch Alan E.	Elements of Port Operation and Management (1986), 457 s.
/2/	Dar Es Salaam Port project document Phase II	RWA/Overseas Projects Office, Plancenter (1990), 328 s.
/3/	Interviews and year books	Rauma Stevedor: Workshop Manager Koivulahti April 1991.
		Helsinki Harbour Authority, Western port Workshop Manager Laaksonen April 1991.
		Steveco Oy, Kotka Workshop Manager Mikko Mylläri May 1991.
/4/	Holland-Mhidze, Tanzania Harbours Authority	Mechanical Maintenance Procedures (1984) chap. 2-3 560 s.
/5/	Management of Port Equipment Maintenance	World Bank. Report INU 57, (1990) 157 s.
/6/	PIANC Bulletin	No 56 s.100-109, (1987).
/7/	SATCC Project 3.7.2 Draft Final Report	SLI Consultants, (July 1990) 273 s.
/8/	SHIPPING Merikuljetukset ja sen osajärjestelmät.	INSKO 186, (1985) kap. 4,8 130 s.
/9/	UNCTAD, DTI Her Majestys Stationary office	Management of Port Maintenance, (1989) 247 s.

8 APPENDIXES

List of pictures :

Tanzania Harbours Authority

WORK ORDER

APPENDIX 1

PORT ______________ SECTION ______________ DATE ______________

TO: ______________

B WORK REQUEST

INITIATOR	MACHINE/PART*	W/SHOP/REG NO*	EQUIPMENT REMOVED FROM	EXPENDITURE ALLOCATION

SP/WHEEL		JACK		BAT.		TOOLS		MIRROR		MWT	

DATE IN	TIME
DATE REQUIRED	TIME
SIGNATURE AND C/NO	

WORK DESCRIPTION: ______________

______________ AUTHORIZING OFFICER

DATE ______________

C PREPARATION AND PLANNING

OP. NO	WORK/OPERATION	SUB-SECTION	START	EXPECTED COMPLETION	ACTUAL COMPLETION

DRAWINGS AND INSTRUCTIONS:-

DATE ______________

TIME ______________

SIGNATURE ______________

D WORK REPORT	NORMAL		CONTR. IN		CONTR. OUT		WARRANTY	
TYPE OF REPAIR OR WORK, METHOD OF WORK AND COMPLETENESS	CORR MAINT.		PREV. MAINT		ACCIDENT		MODIFICATION.	
	ASSEMBLY		INSTALLAT-ION		PROD.		PROJECT	
	NEW PARTS		REC PARTS		OLD PARTS		NON-CHARGEABLE	
	COMPLETE		INCOMPLETE		AWLAB		AWS/MTL	
DEFECT ANALYSIS:-			AWFAC		PRESTART CHECKS			

SYSTEM	SUB-SYSTEM	COMPONENT	ACTION	MAN HOURS	SYMPTON	PART CONDITION	CAUSE

REMARKS ______________

C/NO ______________ SIGNATURE ______________

E QUALITY CONTROL

FIRST REJECT ______________ SECOND REJECT ______________

PASSED INSPECTION MONTHLY WORK TICKET INITIALED ______________

F MATERIALS EXPENDITURE

F/NO	DESCRIPTION OF MATERIALS	QTY.	SOURCE	COST SHS	COST CTS.

G DIRECT LABOUR EXPENDITURE DETAILS:-

DATE	MANPOWER ALLOCATION				NORMAL HRS	O/T WEEK DAYS HRS	O/T SUNDAYS AND P/HOLIDAYS HRS	TOTAL HRS EQUIVALENT AT ART. II LEVEL
	ART. I	ART. II	ART. III	ASST. ART.				
TOTAL EQUIVALENT MAN HOURS (AT ART. II GRADE)								

H DETAILED REPORTING CODES

SYMPTOMS

01 Inoperative
02 Intermittent
03Low performance
04 Noisy
05 Off Frequency
06 Out of adjustment/ alignment
07 Overheating
08 Unstable/surging
09 Interference/ Binding
10 Excess Vibration
11 Leakage
12 RPM out-of-limit
13 Temperature out- of-limit
14 Pressure out-of-limit
15 Seized
16 High fuel consumption
17 High oil consumption
18 Incorrect Displays
19 Metal in oil
20 Out of Balance
21 Torque out -of-limit
22 Visible defect
23 Insufficient output
24 Low sensitivity
25 Contamination
26 Time expired
27 Low Meter reading
28 Out of specification
29 No background Noise
30 No Scan
31 Excess Current Draw
32 High/Low/No electrical output
33 Arcing/ shorting
34 Poor resolution
35 Low illumination
36 BYTE Error Light
37 Output Noisy
38 Preventive Maintenance
39 Circuit Breaker tripping
40 Requires calibration
41 Requires Confidence check
42 Requires Battery Charging
43 Other

PARTY CONDITION

44 Chafed
45 Broken
46 Cracked
47 Distorted
48 Scored
49 Worn
50 Discoloured
51 Out of Tolenrance
52 Corroded
53 Arced
54 Bearing failed
55 Bent
56 Brush failed
57 Burnt out/ open
58 Changed Value
59 Missing
60 Leaking
61 Chipped
62 Clogged
63 Loose
64 Dented
65 Dirty /
66 Frozen
67 Fungus Effect
68 Grounded
69 Installed Improperly
70 Pinched
71 Pitted
72 Unbalanced
73 Unstable
74 Shorted
75 Cold Solder Joint
76 Seized
77 Other

PROBABLE CAUSE

78 Design Deficiency
79 Normal Use
80 Faulty MFG/ inspection
81 Faulty Maintenance
82 Faulty Rebuild
83 Faulty Calibration
84 Damaged on Receipt
85 Wealther Contion
86 Contamination
87 Foreign OBJ/Combat
88 Other parts
89 Faulty Preservation
90 Misuse
91 Undetermined
92 Other

ACTION

PI - INSPECTED preventively
PA - ADJUSTED preventively
PR - REPAIRED preventively
PC - REPLACED preventively
CI - INSPECTED correctively
CA - ADJUSTED correctively
CR - REPAIRED correctively
CC - REPLACED correctively
M - MODIFICATION

NON - CHARGEABLE MAINTENANCE

1 - Accident damage
2 - Misuse, or Fire damage
3 - Fire damage
4 - Faulty work or
5 - Defective material

APPENDIX 2

Tanzania Harbours Authority
Container Terminal Workshops
WORK ORDER

NUMBER:

PAGE /

WORK REQUEST

MACHINE/PART	W/SHOP/REG. NO	DATE IN	TIME	DATE OUT	TIME
WORK DESCRIPTION :	METER READING	INITIATOR		WORKSHOP HOURS	

AUTHORISING OFFICER:

PREPARATION AND PLANNING

OP.NO	WORK/OPERATION	S-SEC	DATE and HOURS				TOTAL
	WAITING FOR SPARES						
	WAITING FOR						
DRAWINGS AND INSTRUCTIONS:		TOTAL					

WORKING STAFF

DATE and HOURS

OP/NO	C/NO		O/T		O/T		O/T		O/T		O/T	TOTAL
										TOTAL:		

SUP.VISOR:

SUP.INT.:

MATERIAL EXPENDITURE

OP/NO	PART NO	DESCRIPTION OF MATERIAL	STO. SIGN.	QTY	COST(SHS)
				SUB.TOT :	

LUBRICANTS :

OP/NO	TYPE OF LUBRICANT	STO. SIGN.	QTY	COST(SHS)
			SUB.TOT :	
			TOTAL :	

REMARKS :

MONTH:............

MONTHLY EQUIPMENT TECHNICAL PERFORMANCE

EQUIPMENT:..... No:.........

LOCATION: CT/UBUNGO/KW

Week	Hr-meter reading	Hrs worked	Workshop hours: maintenance	Workshop hours: waiting repair	Workshop hours: waiting spare	Workshop hours: waiting other	Workshop hours: TOTAL	Repair Mn.Hrs	RUNNING COSTS x 1,000 TAS: Cost/MH 0.27 Man Hrs	Spares	Lubricants	Fuel	Tyres Consum.	TOTAL
							0.0		0.0	0.4	5.0			5.4
							0.0		0.0					0.0
							0.0		0.0					0.0
							0.0		0.0					0.0
							0.0		0.0					0.0
	TOTALS	0					0.0		0.0	0.4	5.0	0.0	0.0	5.4

Cost/Running Hour TAS:

Exhange courses:

		TAS
USD	1	197
FIM	1	54

APPENDIX 3

APPENDIX 4

Singapore Harbour Authority
Container Terminal Workshop

EQUIPMENT SERVICE REQUEST

☐ BREAKDOWN ☐ SERVICE

CAUSE :

____

____

____

____

	DATE	TIME
Delivered to workshop :		
Signature : _______________		
Service compleated		
Signature : _______________		
Returned to operation		
Signature : _______________		

APPENDIX 5

Tanzania Harbours Authority

WEEKLY MAINTENANCE SCHEDULE

WEEK :

DUE FOR SERVICE	TYPE OF SERVICE	EXPECTED DURATION	DATE PROP. BY OPER.

TANZANIA HARBOURS AUTHORITY
CONTAINER TERMINAL

DAILY EQUIPMENT ALLOCATION FORM

DATE : ______________________

	NO: EQU.	AVAI-LABLE	BERTH 9			BERTH 10			BERTH 11			EMPTY			RAIL TERM.	PORT / PORT	ICD TRANS.
			SHIFT II	SHIFT III	SHIFT I	SHIFT II	SHIFT III	SHIFT I	SHIFT II	SHIFT III	SHIFT I	SHIFT II	SHIFT III	SHIFT I			
SSG 1	1																
SSG 2	1																
RMG	1																
RTG	5																
TT SISU	17																
TT UNIMAC	8																
TRACTORS	5																
FLV 42	2																
FLl 42	2																
SP	[illegible]																
FH 16	3																
FL 2	[illegible]																
LOKOMO	2																
LOCATELLI	5																
HT SISU	12																

PREPAIRED BY : ______________________
O.O.EQ.

SIGNED BY : ______________________
P.O.O. P. / S

APPENDIX 6

CTEM - TA.

CONTAINER TERMINAL EQUIPMENT WORKSHOP NUMBERS

GROUP: 000 HIGHWAY/TERMINAL/SHUNTER TRACTORS
100 HIGHWAY/TERMINAL/ROLL TRAILERS
200 MOBILE CRANES
300 FORKLIFT TRUCKS
400 LIGHT VEHICLES
500 WORKSHOP EQUIPMENT
600 ELECTRICAL INSTALLATION

	W/S NUMBER	SER.NO.	REMARKS
GROUP 000 HIGHWAY/TERMINAL/SHUNTER TRACTORS			
SISU SL 210	U-70-HTS-86-005	37694	
	U-70-HTS-86-006	37695	
	U-70-HTS-86-007	37699	
	U-70-HTS-86-008	37700	
	U-70-HTS-86-009	37702	
	U-70-HTS-86-010	37705	
	U-70-HTS-86-011	37696	
	U-70-HTS-86-012	37697	
	U-70-HTS-86-013	37698	
	U-70-HTS-86-014	37701	
	U-70-HTS-86-015	37703	
	U-70-HTS-86-016	37704	
SISU TT-160	C-40-TTS-86-017	38083	
	C-40-TTS-86-018	38084	
	C-40-TTS-86-019	38085	
	C-40-TTS-87-020	38086	
	C-40-TTS-87-021	38087	
	C-40-TTS-87-022	38138	
	C-40-TTS-87-023	38139	
	C-40-TTS-87-024	38140	
	C-40-TTS-87-025	38141	
	C-40-TTS-87-026	38142	
	C-40-TTS-87-027	38128	
	C-40-TTS-87-028	38129	
	C-40-TTS-87-029	38130	
	C-40-TTS-87-030	38131	
	C-40-TTS-87-031	38132	
	C-40-TTS-87-032	38133	
	C-40-TTS-87-033	38134	
	C-40-TTS-87-034	38135	
	C-40-TTS-87-035	38136	
	C-40-TTS-87-036	38137	
LINMAC	C-TTU-90-050	839	
	C-TTU-90-051	849	
	C-TTU-90-052	859	
	C-TTU-90-053	869	
	C-TTU-90-054	879	
	C-TTU-90-055	889	
	C-TTU-90-056	899	
	C-TTU-90-057	8109	
	C-TTU-90-058	8119	
	C-TTU-90-059	8129	
	C-TTU-90-060	8139	
	C-TTU-90-061	8149	

APPENDIX 8

TANZANIA HARBOURS AUTHORITY

EQUIPMENT HISTORY CARD

PORT: SECTION:

EQUIPMENT DESCRIPTION	WORKSHOP NO.	THA ASSET NO:	
MANUFACTURE	MODEL	BASIC CAPACITY	MANUFACTURE S/NO.
ENGINE TYPE AND MODEL	ENGINE S/NO	DATE IN	PRICE
ALLOCATION	OTHER INFORMATION		

MAINTENANCES HISTORY

DATE	WORK ORDER NO.	DESCRIPTION OF WORK	TOTAL DOWN TIME	TOTAL REPAIR TIME	MATERIAL COST	LABOUR COST	REMARKS

```
;EMIS mainprogram c:27.4.1991

RESET
CLEAR
STYLE REVERSE,BLINK
@ 12,10
?? "  Engineering Management Information System  "
STYLE
@ 21,10
?"Created by : P.G.Ellmn copyright 1991"
?"RWA/FinnRA phone: 358-0-1541 "

SLEEP 2000

WHILE(TRUE)
 SHOWMENU
  "FILL"    :"FILL IN NEW DATA",
  "REPORTS" :"PRINT REPORTS TO PRINTER",
  "NEW"     :"CREATE NEW WORK ORDER TABLE",
  "QUIT"    :"QUIT THE PROGRAM"
 DEFAULT "QUIT"
 TO choise                                    ;store the user choise
 SWITCH
  CASE choise="FILL"    :PLAY "FILL"
  CASE choise="REPORTS" :PLAY "REPORTS"
  CASE choise="NEW"     :PLAY "NEW"
  CASE (choise="QUIT") OR (choise="Esc") :QUITLOOP
 ENDSWITCH
ENDWHILE
QUIT
```

```
;EMIS subprogram FILL.SC
;VARIABLES

CLEARALL
CLEAR


SHOWFILES NOEXT
"C:*.DB"
"CHOOSE THE TABLE TO FILL IN (Esc to RETURN) "
TO tblname

@ 12,10 ?"THE CHOSEN TABLE IS ",tblname
SLEEP 2000

IF tblname="None" OR tblname="Esc"  ;check for a valid tablename
 THEN RETURN
ENDIF

EDIT tblname PICKFORM "F"              ;standard form
MOVETO RECORD NRECORDS(TABLE())        ;last record
PGDN                                   ;create a new record

WAIT TABLE
PROMPT " Press F2 to update or ESC to return without updating",
       " use arrows to move in some fields get HELP with F1"
MESSAGE "EDITING TABLE "+tblname
UNTIL "F2","Esc"

IF retval="Esc"
     THEN CANCELEDIT
          CLEARALL
          CLEAR
          @ 10,12 ??"NO CHANGES MADE TO THE TABLE"
     ELSE DO_It!
          CLEARALL
          CLEAR
          @ 10,12 ??"CHANGES UPDATED"
ENDIF

RESET
RETURNWHILE(TRUE)
 SHOWMENU
  "TABLES"  :"REPORT OF EXISTING TABLES",
  "OTHER"   :"CALCULATED REPORTS",
  "RETURN"  :"RETURN TO MAIN MENU"
 DEFAULT "RETURN"
 TO choise  ;store the user choise
 SWITCH
  CASE choise="TABLES"    :PLAY "WO-REP"
  CASE choise="OTHER"     :PLAY "OT-REP"
  CASE (choise="RETURN") OR (choise="Esc") :QUITLOOP
 ENDSWITCH
ENDWHILE
RETURN
```

```
; EMIS subprogram REPORTS.SC

WHILE(TRUE)
 SHOWMENU
  "TABLES"   :"REPORT OF EXISTING TABLES",
  "OTHER"    :"CALCULATED REPORTS",
  "RETURN"   :"RETURN TO MAIN MENU"
 DEFAULT "RETURN"
 TO choise  ;store the user choise
 SWITCH
  CASE choise="TABLES"   :PLAY "WO-REP"
  CASE choise="OTHER"    :PLAY "OT-REP"
  CASE (choise="RETURN") OR (choise="Esc") :QUITLOOP
 ENDSWITCH
ENDWHILE
RETURN
```

```
; EMIS subprogram WO-REP.SC

CLEAR
status="True"
SHOWTABLES
  "C:"
  "CHOOSE THE TABLE AND PRESS ENTER"
TO tblname

SHOWMENU
"R"       :"STANDARD REPORT",
"1"       :"FIRST MODIFIED REPORT",
"2"       :"SECOND MODIFIED REPORT",
"3"       :"THIRD MODIFIED REPORT"
TO rep

SHOWMENU
"SCREEN"       :"SCREEN",
"PRINTER"      :"PRINTER MUST BE ON"
TO device

@ 10,10 ?"STARTING THE REPORT OUTPUT...!"
IF device="PRINTER" THEN status=PRINTERSTATUS() ENDIF


IF status=False
   THEN BEEP CLEAR MESSAGE "YOUR PRINTER WAS NOT ON..RETURNING" RETURN
ENDIF
MENU {REPORT} {OUTPUT} TYPEIN tblname ENTER SELECT rep SELECT device
CLEAR



; EMIS subprogram OT-REP.SC


WHILE(TRUE)
 SHOWMENU
  "MTTR"     :"MEAN TIME TO REPAIR",
  "MTBF"     :"MEAN TIME BETWEEN FAILURES",
  "RETURN"   :"RETURN TO MAIN MENU"
 DEFAULT "RETURN"
 TO choise  ;store the user choise
 SWITCH
  CASE choise="MTTR"    :PLAY "MTTR1"
  CASE choise="MTBF"    :PLAY "MTBF1"
  CASE (choise="RETURN") OR (choise="Esc") :QUITLOOP
 ENDSWITCH
ENDWHILE
RETURN
```

```
;EMIS subprogram MTBF1.SC
;VARIABELS
cond1="NOT y,NOT Y"
mtbf=0
sumtbf=0
emp="n"
n=1


CLEAR

SHOWFILES NOEXT
"C:W*.DB"
"CHOOSE THE TABLE TO CALCULATE FROM"
TO tblname
@ 12,10 ?"CHOSEN TABLE IS ",tblname
SLEEP 1000

IF tblname="None" OR tblname="Esc"
THEN RETURN
ENDIF

CLEAR
STYLE REVERSE
@ 12,10 ?" GIVE THE NUMBER OF THE MACHINE (0 to return) :"
ACCEPT "N" TO machine
STYLE
IF machine=0
THEN RETURN
ENDIF


;OPEN THE WORKODER TABLE AND COPY IT TO TABLE "ANSWER"
{ASK} TYPEIN tblname ENTER
CHECKPLUS
DO_It!
CLEARALL

;EXTRACT THOSE W-ORDERS OF THE MACHINE WICH AREN'T PREVENTIVE MAINTENANCE
{ASK} "ANSWER" ENTER
CHECK
MOVETO [WS-REG-NO]
TYPEIN machine
MOVETO [PRE-MAINT]
TYPEIN cond1
DO_It!

;SORT THE TABLE ACCORDING TO THE W-ORDER DATEIN VALUES
SORT "ANSWER" ON "DATEIN"
MOVETO [DATEIN]
n=(NRECORDS("ANSWER")-1)
IF n<=0
   THEN STYLE BLINK
        CLEAR
        @ 12,12 ?"NO W-ORDERS TO PROCESS RETURNING"
        SLEEP 2000
        STYLE
        CLEARALL
        RETURN
ENDIF
ARRAY tbf[n]

;EXTRACTING THE TIMES FROM THE TABLE
FOR i FROM 1 TO n STEP 1
  d=[DATEIN]
  DOWN
  tbf[i]=[DATEIN]-d
  CLEAR
```

```
  @ 12,10 ?"TIMES BETWEEN FAILURE :",tbf[i]," DAYS"
  SLEEP 500

ENDFOR
CLEAR

;CALCULATING THE SUM OF ALL TIMES
FOR i FROM 1 TO n STEP 1
  sumtbf=sumtbf+tbf[i]
ENDFOR

; CALCULATING THE MEAN TIME
mtbf=sumtbf/n
@ 12,6 ?"MEAN TIME BETWEEN FAILURE FOR ",machine," IS ",mtbf," DAYS"
SLEEP 2000
CLEARALL

IF ISTABLE("MTBF")
   THEN CLEAR
        STYLE REVERSE
        @ 12,10 ?"MTBF TABLE EXISTS SHOULD IT BE EMPTIED (Y/n) ?"
        ACCEPT "A1" TO emp
        STYLE
   ELSE CREATE "MTBF"
         "WS-REG-NO"    :"S",
         "MTBF"         :"N"
ENDIF

IF emp="Y" OR emp="y"
 THEN EMPTY "MTBF"
ENDIF

EDIT "MTBF"
INS
MOVETO [WS-REG-NO]
[WS-REG-NO]=machine
MOVETO [MTBF]
[MTBF]=mtbf
DO_It!
IF ISTABLE("ANSWER")
   THEN DELETE "ANSWER"
ENDIF

RESET
RETURN
```

```
;EMIS subprogram MTTR1.SC
;VARIABLES
cond1="NOT Y,NOT y"                       ;for PRE-MAINT
cond2="CALC SUM ALL AS WSH-TOT"           ;for WS-HOURS
cond3="CALC SUM ALL AS MANH-TOT"          ;for MAN-HOURS
mttrws=0
mttrmh=0
emp="n"
n=1

CLEAR

SHOWFILES NOEXT
"C:W*.DB"
"CHOOSE THE TABLE TO CALCULATE FROM (Esc to RETURN) "
TO tblname

@ 12,10 ?"THE CHOSEN TABLE IS ",tblname
SLEEP 2000

IF tblname="None" OR tblname="Esc"  ;check for a valid tablename
 THEN RETURN
ENDIF

CLEAR
STYLE REVERSE
 @ 12,10 ?" GIVE THE NUMBER OF THE MACHINE (0 to return) :"
 ACCEPT "N" TO machine
 STYLE
IF machine=0
 THEN RETURN
ENDIF


;OPEN THE WORKODER TABLE AND COPY IT TO TABLE "ANSWER"
{ASK} TYPEIN tblname ENTER
 CHECKPLUS
 DO_It!

CLEARALL

;EXTRACT THOSE W-ORDERS OF THE MACHINE WICH AREN'T PREVENTIVE MAINTENANCE
{ASK} "ANSWER" ENTER
 CHECK
 MOVETO [WS-REG-NO]
 TYPEIN machine
 MOVETO [PRE-MAINT]
 TYPEIN cond1
DO_It!

;EXTRACTING THE TIMES FROM THE TABLE
CLEARALL
VIEW "ANSWER"
 n=NRECORDS("ANSWER")
 CLEAR
 @ 10,12 ?"NUMBER OF W-ORDERS FOR ",machine," IS ",n
 IF n=0
  THEN STYLE BLINK
       @ 12,12 ?"NO WORK ORDERS TO PROCESS RETURNING "
       SLEEP 2000
       STYLE
       RESET
       RETURN
 ENDIF

CLEARALL

{ASK} "ANSWER" ENTER
```

```
 MOVETO [WS-REG-NO]
 CHECK


 MOVETO [WS-HOURS]
 TYPEIN cond2
 MOVETO [MAN-HOURS]
 TYPEIN cond3
DO_IT!

CLEARALL

; CALCULATING THE MEAN TIME
CLEAR
VIEW "ANSWER"
mttrws=[WSH-TOT]/n
mttrmh=[MANH-TOT]/n
@ 12,6 ?"MEAN WS-HOURS TO REPAIR ",machine," IS ",FORMAT("W8.2",mttrws)
@ 14,6 ?"MEAN MAN-HOURS TO REPAIR ",machine," IS ",FORMAT("W8.2",mttrmh)
SLEEP 5000
STYLE
CLEARALL

;INSERTING THE CALCULATED VALUES IN A TABLE
IF ISTABLE("MTTR")
   THEN CLEAR
        STYLE REVERSE
        @ 12,10 ?"MTTR TABLE EXISTS SHOULD IT BE EMPTIED (Y/n) ?"
        ACCEPT "A1" TO emp
        STYLE
   ELSE CREATE "MTTR"
         "WS-REG-NO"      :"S",
         "MTTRWS"         :"N",
         "MTTRMH"         :"N"
ENDIF

IF emp="Y" OR emp="y"
 THEN EMPTY "MTTR"
ENDIF

EDIT "MTTR"
INS
MOVETO [WS-REG-NO]
[WS-REG-NO]=machine
MOVETO [MTTRWS]
[MTTRWS]=mttrws
MOVETO [MTTRMH]
[MTTRMH]=mttrmh
DO_It!

IF ISTABLE("ANSWER")
   THEN DELETE "ANSWER"
ENDIF

RESET
RETURN
```

```
;EMIS subprogram NEW.SC c:27.4.1991
;VARIABLES
name=STRVAL(YEAR(TODAY()))
tblname=""

CLEAR

STYLE REVERSE
@ 10,12 ??"MAKING A NEW WORK ORDER TABLE GIVE THE YEAR"
@ 14,12 ??"FOR THE TABLE NAME (format yyyy) :"
ACCEPT "A4" PICTURE "####" DEFAULT name TO name
STYLE

tblname="WO"+name

;CHECK FOR EXISTING TABLES AND CREATE IF NONE & COPY FORMS & REPORTS
IF ISTABLE(tblname)
   THEN CLEAR
        @ 10,12 ?"THE TABLE ",tblname," ALREDY EXISTS RETURNING.."
        SLEEP 2000
        RETURN
   ELSE CREATE tblname LIKE "MODELWO"
        CLEARALL
        CLEAR
        @ 10,12 ??"CREATING THE TABLE ",tblname
        MENU {TOOLS} {COPY} {JUSTFAMILY}
        "MODELWO" ENTER TYPEIN tblname ENTER {REPLACE}
ENDIF
RESET
RETURN
```

EMIS
WORK ORDER
Standard report

.05.91

S- G-NO	WORK OR.	DATEIN	DATEOUT	WS-H	MAN-H	LUB. LTR	PRE MAIN	CAUSE	H-METER
207	90/11/ 46	11.12.90	21.12.90	15	22	5		500	
21	90/11/ 77	22.11.90	23.11.90	10	23			100	5237
305	90/11/ 86	16.11.90	30.11.90	16	60			400	
301	90/11/ 87	20.11.90	25.11.90	24	110			200	1053
21	90/11/ 92	21.11.90	21.11.90	6	11				5233
14	90/11/ 96	22.11.90	22.11.90	8	14		Y		25002
17	90/11/101	23.11.90	23.11.90	6	6			400	
25	90/11/103	23.11.90	23.11.90	6	11	30	Y		4389
28	90/11/104	22.11.90	23.11.90	6	5			900	2896
16	90/11/105	23.11.90	23.11.90	1	1			400	
181	90/11/109	24.11.90	24.11.90	3	3			500	
19	90/11/110	24.11.90	24.11.90	1	1			400	
165	90/11/111	24.11.90	24.11.90	1	2			400	
30	90/11/113	26.11.90	24.11.90	1	1			500	3048
31	90/11/117	27.11.90	27.11.90	5	10		Y		3152
26	90/11/118	1.12.90	1.12.90	3	5	3	Y		
303	90/11/123	28.11.90	29.11.90	6	80			100	
303	90/11/124	29.11.90	29.11.90	8	22		Y		5104
11	90/11/136	29.11.90	29.11.90	1	1			500	
212	90/11/138	30.11.90	3.12.90	13	26		Y		
186	90/11/141	30.11.90	1.12.90	1	1			400	
		TOTAL of WO's in month 11 : 21							
8	90/12/ 4	1.12.90	1.12.90	1	2			900	
24	90/12/ 6	1.12.90	1.12.90	3	6			400	4564
303	90/12/ 55	12.11.90	14.11.90					900	
303	90/12/ 87	30.11.90	29.11.90				Y		
303	90/12/100	30.11.90	29.11.90						
		TOTAL of WO's in month 12 : 5							

TOTAL of WORK ORDERS : 26

EMIS
WORK ORDER
1.05.91 Maintenance pro Machine Page 2

WORK OR.	DATEIN	DATEOUT	WS-H	MAN-H	LUB. ltr.	PRE MAIN	MAINT. CAUSE	H-METER
	TOTAL WO pro MACHINE no: 181				:	1		
0/11/141	30.11.90	1.12.90	1	1			400	
	TOTAL WO pro MACHINE no: 186				:	1		
0/11/ 46	11.12.90	21.12.90	15	22	5		500	
	TOTAL WO pro MACHINE no: 207				:	1		
0/11/138	30.11.90	3.12.90	13	26		Y		
	TOTAL WO pro MACHINE no: 212				:	1		
0/11/ 87	20.11.90	25.11.90	24	110			200	1053
	TOTAL WO pro MACHINE no: 301				:	1		
0/11/123	28.11.90	29.11.90	6	80			100	
0/11/124	29.11.90	29.11.90	8	22		Y		5104
0/12/ 55	12.11.90	14.11.90					900	
0/12/ 87	30.11.90	29.11.90				Y		
0/12/100	30.11.90	29.11.90						
	TOTAL WO pro MACHINE no: 303				:	5		
0/11/ 86	16.11.90	30.11.90	16	60			400	
	TOTAL WO pro MACHINE no: 305				:	1		

TOTAL of WORK ORDERS : 25

EMIS
WORK ORDER
Maintenance pro Machine

	DATEIN	DATEOUT	WS-H	MAN-H	LUB. ltr.	PRE MAIN	MAINT. CAUSE	H-METER
	1.12.90	1.12.90	1	2			900	
	TOTAL WO pro MACHINE no: 8 : 1							
	29.11.90	29.11.90	1	1			500	
	TOTAL WO pro MACHINE no: 11 : 1							
	22.11.90	22.11.90	8	14		Y		25002
	TOTAL WO pro MACHINE no: 14 : 1							
	23.11.90	23.11.90	1	1			400	
	TOTAL WO pro MACHINE no: 16 : 1							
	23.11.90	23.11.90	6	6			400	
	TOTAL WO pro MACHINE no: 17 : 1							
	24.11.90	24.11.90	1	1			400	
	TOTAL WO pro MACHINE no: 19 : 1							
7	22.11.90	23.11.90	10	23			100	5237
2	21.11.90	21.11.90	6	11				5233
	TOTAL WO pro MACHINE no: 21 : 2							
6	1.12.90	1.12.90	3	6			400	4564
	TOTAL WO pro MACHINE no: 24 : 1							
3	23.11.90	23.11.90	6	11	30	Y		4389
	TOTAL WO pro MACHINE no: 25 : 1							
8	1.12.90	1.12.90	3	5	3	Y		
	TOTAL WO pro MACHINE no: 26 : 1							
4	22.11.90	23.11.90	6	5			900	2896
	TOTAL WO pro MACHINE no: 28 : 1							
3	26.11.90	24.11.90	1	1			500	3043
	TOTAL WO pro MACHINE no: 30 : 1							
1	24.11.90	24.11.90	1	2			400	
	TOTAL WO pro MACHINE no: 165 : 1							
9	24.11.90	24.11.90	3	3			500	

TOTAL of WORK ORDERS : 15

EMIS
WORK ORDER

1.05.91 Maintenace pro maintenance type Page 1

WS- EG-NO	WORK ORDER	DATEIN	DATEOUT	WS-H	MAN-H	LUB. LTR	PRE MAIN	H-METE
21	TTS /90/11/ 92	21.11.90	21.11.90	6,0	11,0			5233
14	HTS /90/11/ 96	22.11.90	22.11.90	8,0	14,0		Y	25002
25	TTS /90/11/103	23.11.90	23.11.90	6,0	11,0	30,0	Y	4389
26	TTS /90/11/118	1.12.90	1.12.90	2,5	5,0	3,0	Y	
303	FLT /90/11/124	29.11.90	29.11.90	7,5	22,0		Y	5104
212	SKY /90/11/138	30.11.90	3.12.90	13,0	26,0		Y	
303	FLT /90/12/ 87	30.11.90	29.11.90				Y	
303	FLT /90/12/100	30.11.90	29.11.90					

MAINTENED of type TOTAL : 8 used man hours total: 89,0

21	TTS /90/11/ 77	22.11.90	23.11.90	10,0	22,5			5237
303	FLT /90/11/123	28.11.90	29.11.90	6,3	80,0			

MAINTENED of type 100 TOTAL : 2 used man hours total: 102,5

301	FLT /90/11/ 87	20.11.90	25.11.90	24,0	110,0			1053

MAINTENED of type 200 TOTAL : 1 used man hours total: 110,0

305	FLT /90/11/ 86	16.11.90	30.11.90	16,0	60,0			
17	TTS /90/11/101	23.11.90	23.11.90	5,5	5,5			
16	HTS /90/11/105	23.11.90	23.11.90	1,0	1,0			
19	TTS /90/11/110	24.11.90	24.11.90	0,5	1,0			
165	TTS /90/11/111	24.11.90	24.11.90	1,0	1,5			
186	HTS /90/11/141	30.11.90	1.12.90	1,0	1,0			
24	TTS /90/12/ 6	1.12.90	1.12.90	3,3	5,5			4564

MAINTENED of type 400 TOTAL : 7 used man hours total: 75,5

207	SSG /90/11/ 46	11.12.90	21.12.90	15,0	21,5	5,0		
181	HTS /90/11/109	24.11.90	24.11.90	3,0	3,0			
30	TTS /90/11/113	26.11.90	24.11.90	1,0	1,0			3043
11	HTS /90/11/136	29.11.90	29.11.90	1,0	1,0			

MAINTENED of type 500 TOTAL : 4 used man hours total: 26,5

28	TTS /90/11/104	22.11.90	23.11.90	6,0	5,0			2896
8	HTS /90/12/ 4	1.12.90	1.12.90	1,0	2,0			
303	FLT /90/12/ 55	12.11.90	14.11.90					

MAINTENED of type 900 TOTAL : 3 used man hours total: 7,0

TOTAL of WORK ORDERS : 25

EMIS
WORK ORDER

1.05.91 Cost of Maintenance pro Machine Page 1

WS- EG-NO	WORK OR.	WS-H	MAN-H	PRE MAIN	CAUSE	The COST of MAINTENANCE (USD) MAN HOUR	 PARTS	 LUBRICANTS
8	90/12/ 4	1	2		900	456,00	3446,00	45454,00
TOTALS for MACHINE HIGHWAY TRACTOR			8 :			456,00	3446,00	45454,00
11	90/11/136	1	1		500	345,00	454,00	232,00
TOTALS for MACHINE HIGHWAY TRACTOR			11 :			345,00	454,00	232,00
14	90/11/ 96	8	14	Y		120,00	1000,00	233,00
TOTALS for MACHINE HIGHWAY TRACTOR			14 :			120,00	1000,00	233,00
16	90/11/105	1	1		400	4553,00	4545,80	2342,00
TOTALS for MACHINE HIGHWAY TRACTOR			16 :			4553,00	4545,80	2342,00
17	90/11/101	6	6		400	2456,00	4455,60	234,00
TOTALS for MACHINE TERMINAL TRACTOR			17 :			2456,00	4455,60	234,00
19	90/11/110	1	1		400	3342,00		3,00
TOTALS for MACHINE TERMINAL TRACTOR			19 :			3342,00	0,00	3,00
21	90/11/ 77	10	23		100	866,00		34,00
21	90/11/ 92	6	11			565,00	4545,70	3,00
TOTALS for MACHINE TERMINAL TRACTOR			21 :			1431,00	4545,70	37,00
24	90/12/ 6	3	6		400	565,00	3435,80	343,00
TOTALS for MACHINE TERMINAL TRACTOR			24 :			565,00	3435,80	343,00
25	90/11/103	6	11	Y		345,00	6778,00	45,00
TOTALS for MACHINE TERMINAL TRACTOR			25 :			345,00	6778,00	45,00
26	90/11/118	3	5	Y				56,00
TOTALS for MACHINE TERMINAL TRACTOR			26 :			0,00	0,00	56,00
28	90/11/104	6	5		900			5,53
TOTALS for MACHINE TERMINAL TRACTOR			28 :			0,00	0,00	5,53
30	90/11/113	1	1		500			435,30

TOTAL of WORK ORDERS 13

WS-REG-NO	WORK OR.	WS-H	MAN-H	PRE MAIN	CAUSE	The COST of MAINTENANCE (USD) MAN HOUR	PARTS	LUBRICANTS
TOTALS for MACHINE 30 : TERMINAL TRACTOR						0,00	0,00	435,30
165	90/11/111	1	2		400			454,40
TOTALS for MACHINE 165 : TERMINAL TRAILER						0,00	0,00	454,40
181	90/11/109	3	3		500			434,00
TOTALS for MACHINE 181 : HIGHWAY TRAILER						0,00	0,00	434,00
186	90/11/141	1	1		400			4545,44
TOTALS for MACHINE 186 : HIGHWAY TRAILER						0,00	0,00	4545,44
207	90/11/ 46	15	22		500			
TOTALS for MACHINE 207 : S-S GANTRY CRANE						0,00	0,00	0,00
212	90/11/138	13	26	Y				
TOTALS for MACHINE 212 : SKY LIFT						0,00	0,00	0,00
301	90/11/ 87	24	110		200			
TOTALS for MACHINE 301 : FORK LIFT TRUCK						0,00	0,00	0,00
303	90/11/123	6	80		100			
303	90/11/124	8	22	Y		6567,00	454656,00	
303	90/12/ 55				900	343,00	23424,67	234,00
303	90/12/ 87			Y		3434,00	23323,45	324,00
303	90/12/100					3453,00	34243,30	324,00
TOTALS for MACHINE 303 : FORK LIFT TRUCK						13797,00	535647,42	882,00
305	90/11/ 86	16	60		400			
TOTALS for MACHINE 305 : FORK LIFT TRUCK						0,00	0,00	0,00

TOTAL of WORK ORDERS 25

CONTAINER TERMINAL MACHINES

3.04.91 Standard report

WS-REG-NO	MACHINE DESCRIPTION	MANU-FACTURER	MODEL	SERIAL NO: of MANUFAC.	TYPE of ENGINE	SERIAL NO of ENGINE	CAPA-CITY	PROCURED	REMARKS
	MACHINE TYPE : FLT								
301	FORK LIFT TRUCK	VALMET	4212	40038			42 t		
303	FORK LIFT TRUCK	VALMET	4212	40035			42 t		
304	FORK LIFT TRUCK	VALMET	1612	16248			16 t		
305	FORK LIFT TRUCK	HYSTER	20	138E1921A			20 t		
310	FORK LIFT TRUCK	VALMET	1612	8804H0066783			16 t		
311	FORK LIFT TRUCK	VALMET	1612	8804H0067783			16 t		
315	FORK LIFT TRUCK	LANCING	16	8804H0006717			16 t		
316	FORK LIFT TRUCK	LANCING	16	8804H0007177			16 t		
317	FORK LIFT TRUCK	LANCING	16	8804H0008717			16 t		
	MACHINE TYPE : HTS								
8	HIGHWAY TRACTOR	SISU	SL 210	37700			t		
11	HIGHWAY TRACTOR	SISU	SL 210	37694			t		
12	HIGHWAY TRACTOR	SISU	SL 210	37697			t		
14	HIGHWAY TRACTOR	SISU	SL 210	37701			t		
16	HIGHWAY TRACTOR		SL 210	37704			t		
181	HIGHWAY TRAILER	SISU		86054			t		
186	HIGHWAY TRAILER	SISU		86057			t		
	MACHINE TYPE : RTG								
253	RUBBER TYRED G-C	VALMET	35.6	400274			36 t		
254	RUBBER TYRED G-C	VALMET	35.6	400275			36 t		
255	RUBBER TYRED G-C	VALMET	35.6	400276			36 t		
256	RUBBER TYRED G-C	VALMET	35.6	400277			36 t		
257	RUBBER TYRED G-C	VALMET	35.6	400278			36 t		
	MACHINE TYPE : SKY								
212	SKY LIFT	SKYLIFT	123426112	123426112			t		
	MACHINE TYPE : SSG								
207	S-S GANTRY CRANE	KONE		K-9396			t		
208	S-S GANTRY CRANE	KONE		K-9397			t		
	MACHINE TYPE : TTS								
17	TERMINAL TRACTOR		SL 160	38083			t		
19	TERMINAL TRACTOR	SISU	SL 160	38085			t		

EMIS
CONTAINER TERMINAL MACHINES
1.05.91 MACHINES pro MANUFACTURER Page 1

WS-REG-NO	MACHINE DESCRIPTION	MANU-FACTURER	MODEL	SERIAL NO: of MANUFAC.	TYPE of ENGINE	SERIAL of ENGI
	MACHINE TYPE : HTS					
16	HIGHWAY TRACTOR		SL 210	37704		
	MACHINE TYPE : TTS					
17	TERMINAL TRACTOR		SL 160	38083		
		MACHINES from		: 2		
	MACHINE TYPE : FLT					
305	FORK LIFT TRUCK	HYSTER	20	138E1921A		
		MACHINES from HYSTER		: 1		
	MACHINE TYPE : SSG					
207	S-S GANTRY CRANE	KONE		K-9396		
208	S-S GANTRY CRANE	KONE		K-9397		
		MACHINES from KONE		: 2		
	MACHINE TYPE : FLT					
315	FORK LIFT TRUCK	LANCING	16	8804H0006717		
316	FORK LIFT TRUCK	LANCING	16	8804H0007177		
317	FORK LIFT TRUCK	LANCING	16	8804H0008717		
		MACHINES from LANCING		: 3		
	MACHINE TYPE : HTS					
8	HIGHWAY TRACTOR	SISU	SL 210	37700		
11	HIGHWAY TRACTOR	SISU	SL 210	37694		
12	HIGHWAY TRACTOR	SISU	SL 210	37697		
14	HIGHWAY TRACTOR	SISU	SL 210	37701		
181	HIGHWAY TRAILER	SISU		86054		
186	HIGHWAY TRAILER	SISU		86057		
	MACHINE TYPE : TTS					
19	TERMINAL TRACTOR	SISU	SL 160	38085		
21	TERMINAL TRACTOR	SISU	SL 160	38087		
22	TERMINAL TRACTOR	SISU	SL 160	38138		
24	TERMINAL TRACTOR	SISU	SL 160	38140		
25	TERMINAL TRACTOR	SISU	SL 160	38141		
26	TERMINAL TRACTOR	SISU	SL 160	38142		
28	TERMINAL TRACTOR	SISU	SL 160	38129		
30	TERMINAL TRACTOR	SISU	SL 160	38131		
31	TERMINAL TRACTOR	SISU	SL 160	38132		
158	TERMINAL TRAILER	SISU		43		
165	TERMINAL TRAILER	SISU		50		
		MACHINES from SISU		: 17		
	MACHINE TYPE : SKY					
212	SKY LIFT	SKYLIFT	123426112	123426112		
		MACHINES from SKYLIFT		: 1		
	MACHINE TYPE : FLT					
301	FORK LIFT TRUCK	VALMET	4212	40038		
303	FORK LIFT TRUCK	VALMET	4212	40035		
304	FORK LIFT TRUCK	VALMET	1612	16248		
310	FORK LIFT TRUCK	VALMET	1612	8804H0066783		
311	FORK LIFT TRUCK	VALMET	1612	8804H0067783		
	MACHINE TYPE : RTG					
253	RUBBER TYRED G-C	VALMET	35.6	400274		
254	RUBBER TYRED G-C	VALMET	35.6	400275		
255	RUBBER TYRED G-C	VALMET	35.6	400276		
256	RUBBER TYRED G-C	VALMET	35.6	400277		
257	RUBBER TYRED G-C	VALMET	35.6	400278		
		MACHINES from VALMET		: 10		

TOTAL of MACHINES : 36

EMIS
CONTAINER TERMINAL MACHINES
1.05.91 Dates of Procurement Page 1

WS-REG-NO	MACHINE DESCRIPTION	MANU-FACTURER	TYPE of ENGINE	CAPA-CITY	PROCURED
301	FORK LIFT TRUCK	VALMET		42 t	
303	FORK LIFT TRUCK	VALMET		42 t	
304	FORK LIFT TRUCK	VALMET		16 t	
305	FORK LIFT TRUCK	HYSTER		20 t	
310	FORK LIFT TRUCK	VALMET		16 t	
311	FORK LIFT TRUCK	VALMET		16 t	
315	FORK LIFT TRUCK	LANCING		16 t	
316	FORK LIFT TRUCK	LANCING		16 t	
317	FORK LIFT TRUCK	LANCING		16 t	
	MACHINE TYPE FLT TOTAL : 9				
14	HIGHWAY TRACTOR	SISU		t	21.06.87
16	HIGHWAY TRACTOR			t	3.04.87
12	HIGHWAY TRACTOR	SISU		t	31.05.86
11	HIGHWAY TRACTOR	SISU		t	25.05.86
8	HIGHWAY TRACTOR	SISU		t	23.04.86
181	HIGHWAY TRAILER	SISU		t	
186	HIGHWAY TRAILER	SISU		t	
	MACHINE TYPE HTS TOTAL : 7				
253	RUBBER TYRED G-C	VALMET		36 t	
254	RUBBER TYRED G-C	VALMET		36 t	
255	RUBBER TYRED G-C	VALMET		36 t	
256	RUBBER TYRED G-C	VALMET		36 t	
257	RUBBER TYRED G-C	VALMET		36 t	
	MACHINE TYPE RTG TOTAL : 5				
212	SKY LIFT	SKYLIFT		t	
	MACHINE TYPE SKY TOTAL : 1				
207	S-S GANTRY CRANE	KONE		t	

TOTAL of MACHINES : 23

EMIS
CONTAINER TERMINAL MACHINES
1.05.91 Dates of Procurement

WS-REG-NO	MACHINE DESCRIPTION	MANU-FACTURER	TYPE of ENGINE	CAPA-CITY	PROCURED
208	S-S GANTRY CRANE	KONE		t	
	MACHINE TYPE SSG TOTAL : 2				
19	TERMINAL TRACTOR	SISU		t	3.05.89
17	TERMINAL TRACTOR			t	4.04.88
21	TERMINAL TRACTOR	SISU		t	
22	TERMINAL TRACTOR	SISU		t	
24	TERMINAL TRACTOR	SISU		t	
25	TERMINAL TRACTOR	SISU		t	
26	TERMINAL TRACTOR	SISU		t	
28	TERMINAL TRACTOR	SISU		t	
30	TERMINAL TRACTOR	SISU		t	
31	TERMINAL TRACTOR	SISU		t	
158	TERMINAL TRAILER	SISU		t	
165	TERMINAL TRAILER	SISU		t	
	MACHINE TYPE TTS TOTAL : 12				

TOTAL of MACHINES : 36

EMIS
CONTAINER TERMINAL MACHINES
1.05.91 Basic Information

WS-REG-NO	MACHINE DESCRIPTION	MANU-FACTURER	MODEL	TYPE of ENGINE	CAPA-CITY	PROCURED
301	FORK LIFT TRUCK	VALMET	4212		42 t	
303	FORK LIFT TRUCK	VALMET	4212		42 t	
304	FORK LIFT TRUCK	VALMET	1612		16 t	
305	FORK LIFT TRUCK	HYSTER	20		20 t	
310	FORK LIFT TRUCK	VALMET	1612		16 t	
311	FORK LIFT TRUCK	VALMET	1612		16 t	
315	FORK LIFT TRUCK	LANCING	16		16 t	
316	FORK LIFT TRUCK	LANCING	16		16 t	
317	FORK LIFT TRUCK	LANCING	16		16 t	
8	HIGHWAY TRACTOR	SISU	SL 210		t	23.04.86
11	HIGHWAY TRACTOR	SISU	SL 210		t	25.05.86
12	HIGHWAY TRACTOR	SISU	SL 210		t	31.05.86
14	HIGHWAY TRACTOR	SISU	SL 210		t	21.06.87
16	HIGHWAY TRACTOR		SL 210		t	3.04.87
181	HIGHWAY TRAILER	SISU			t	
186	HIGHWAY TRAILER	SISU			t	
253	RUBBER TYRED G-C	VALMET	35.6		36 t	
254	RUBBER TYRED G-C	VALMET	35.6		36 t	
255	RUBBER TYRED G-C	VALMET	35.6		36 t	
256	RUBBER TYRED G-C	VALMET	35.6		36 t	
257	RUBBER TYRED G-C	VALMET	35.6		36 t	
212	SKY LIFT	SKYLIFT	123426112		t	
207	S-S GANTRY CRANE	KONE			t	
208	S-S GANTRY CRANE	KONE			t	
17	TERMINAL TRACTOR		SL 160		t	4.04.88
19	TERMINAL TRACTOR	SISU	SL 160		t	3.05.89
21	TERMINAL TRACTOR	SISU	SL 160		t	
22	TERMINAL TRACTOR	SISU	SL 160		t	
24	TERMINAL TRACTOR	SISU	SL 160		t	
25	TERMINAL TRACTOR	SISU	SL 160		t	
26	TERMINAL TRACTOR	SISU	SL 160		t	
28	TERMINAL TRACTOR	SISU	SL 160		t	
30	TERMINAL TRACTOR	SISU	SL 160		t	
31	TERMINAL TRACTOR	SISU	SL 160		t	
158	TERMINAL TRAILER	SISU			t	
165	TERMINAL TRAILER	SISU			t	

TOTAL of MACHINES : 36

.04.91 Standard Report -

DE	NAME
100	MOTOR
200	TRANSMISSION
300	ELECTRICAL
400	TYRES
500	ACCESSORIES
900	OTHER

ROADS AND WATERWAYS ADMINISTRATIONS
OF FINLAND

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Road Administration

National Board
of Navigation

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